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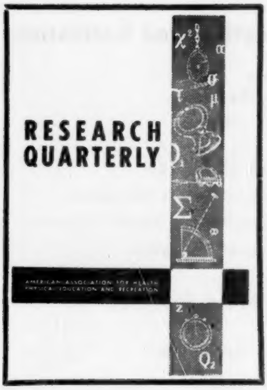

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Specificity vs. Generality in Learning and Performing Two Large Muscle Motor Tasks[1]

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Abstract

The initial and final skill, and amount of learning, were studied on two 10-trial large muscle motor learning tasks. Both males and females were tested (N = 320). The reliability coefficients for individual differences in initial and in final skill were fairly high (.90 to .96). Learning was less reliable (.69 to .87), although even small subgroups showed statistically significant amounts of learning during the ten trials. Even when fully corrected for attenuation, the correlation between individual abilities for performance and for learning, as between the two tasks, was very low and in general nonsignificant. It was concluded that such abilities were highly task-specific, eliminating the possibility of general ability in motor learnng or motor coordination in the types of skills that were studied.

THE ISSUE OF generality vs. specificity of individual differences in large muscle coordination or skill and in motor learning ability has recently aroused considerable interest. Factual data are establishing with increasing clarity that motor skills and large muscle psychomotor abilities are far more specific than has previously been realized. In a paper concerned with generality vs. specificity in the area of motor learning, Henry (3) points out that it is no longer possible to justify the concept of unitary abilities such as coordination and agility, since the evidence shows that these abilities are specific to the task or activity. It is not illogical to assume that individual ability in the learning of motor tasks may also be specific to the task.

Problems Investigated

The present study investigates task specificity vs. generality in the learning of two motor skills involving balance coordinations. In addition, with initial and final performance scores also available, an opportunity is present to investigate the specificity of motor performance as between tasks.

Review of Recent Literature

Scott (6) in 1955 summarized a large number of studies (many of them unpublished theses) in the area of balancing tests and other performances involving kinesthesia. Interest was centered on tests requiring no special apparatus, so that they could readily be used practically by teachers. Original data were also presented. Perhaps her most important conclusion was that "These tests in general show little interrelationship.

[1] From the Research Laboratories of the Department of Physical Education.

This would lead one at present to assume considerable specificity of function." In a 1956 review of research on coordination and motor learning, Henry (2) found that the weight of evidence indicated that individual abilities in large muscle motor skills are highly specific to the particular motor task that is studied.

A more recent review (3) was concerned primarily with task specificity as compared with generality of motor learning ability. In this study there were citations of unpublished as well as published reports, and some original data were presented. In discussing the older views advocating the concept of general motor ability and educability, it was pointed out that when test batteries which incorporate a number of motor skill items are used, there is necessarily some appearance of general motor ability even though no common element is present among the items. A 21-item correlation matrix published in 1957 by Cumbee, Meyer, and Peterson (1) has furnished evidence of the extreme specificity of motor coordination abilities and performances. Another 1957 study by Nelson (5) has found that transfer of motor learning is highly specific.

Apparatus and Method

Stabilometer. This instrument consisted of a horizontally pivoted board upon which the subject stood erect, with his feet 14 in. apart and straddling the supporting axle. The center of rotation in the model used in this experiment was 10 in. higher than the board upon which the subject stood, as shown in the photograph (Figure I). This model of the stabilometer was developed in connection with an experiment on kinesthetic factors in wrestling (4). Presumably the low position of the board made the balancing test easier than in the ordinary stabilometer, particularly for short subjects.

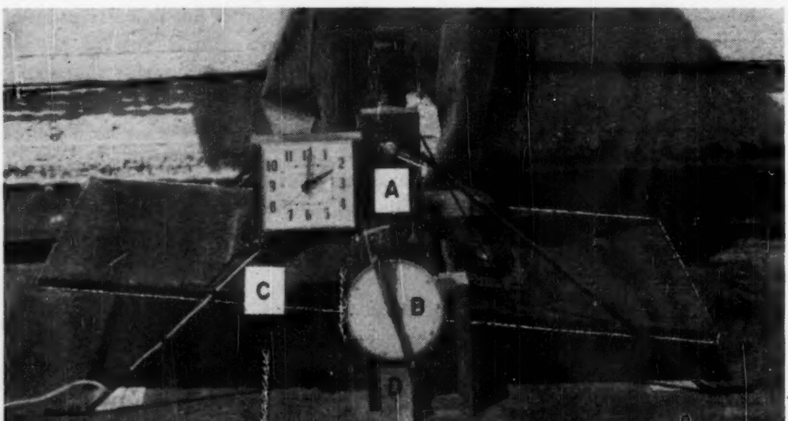

FIGURE I. Stabilometer. A short cord drive lever is screwed into the protruding end of the main axle just above A. The cord passes downward and bends over a large pulley on the back of the work-adder dial B, terminating at a coil spring fastened to the frame just above C. A pawl at D engages the milled periphery of the work-adder dial, restricting its turning to a single direction so that movement of the platform is cumulated on the dial. Various A-frame rods brace the platform and the vertical posts that rise from the base to carry the main axle.

Motion of the board was measured by a work adder. Any movement was transmitted by a 1.5 in. lever arm which was mounted on the axle. A waxed string which was fastened to the lever arm passed over the groove of a pulley 3.63 in. in net diameter that was independently pivoted, the spring being held taut by a coil spring exerting 150 gr. tension. The pulley carried a flat disc 6 in. in diameter and 1/8 in. thick, with a milled or knurled edge. A pawl rested against this edge, permitting easy rotation in one direction, but preventing any movement in the opposite direction. (In the latter case, the string slipped in the pulley groove.) The disc carried a calibrated dial which was scaled in 100 arbitrary units. Each scale unit represented 12 degrees of back and forth platform tilting. Microswitches were fastened under each end of the tilting board and wired in series with an electric clock so that no time was registered during such periods as the subject had the board completely out of balance and against the baseboard and could thereby rest without movement. This provision insured that each 30-second trial represented that much net time of actual balancing effort.

The subject stood on the pivoted platform in an erect position with his eyes open, straddling the pivot rod axle with one foot on either side of it. Each scoring period (trial) lasted 30 seconds of net exposure as registered by the clock. Between trials, the subject stepped off the board for 30 seconds. Ten trials were given rather than five as in previous experiments (4).

Ladder Climb. This apparatus[2] was in reality two parallel ladders with one side in common, the total width being 14 in. (see Figure II). The rungs (made of 1 in. dowling, 5 in. apart) were staggered in the two sections so that the distance from the bottom of the ladder to rung number 16 (the top) was 40 in. A vertical extension was adjusted for each subject in such a manner that its top rung could just be grasped by his upward extended hand. Climbing was done near the middle of a 5 ft. by 10 ft. mat to lessen fear of injury in case of a fall. Tennis shoes were worn by subjects to prevent, as much as possible, slipping off the ladder rungs. In the starting position, the ladder was held by the subject directly in front of him with the toes of both feet placed on the bottom crosspiece. It was required that climbing be done one step at a time.

A trial period lasted 30 seconds; there was a 30-sec. rest period between trial periods. During each period the subject climbed as high as possible before toppling. He then stepped off and started reclimbing immediately. The highest rung upon which a foot was placed (with a deduction for any missed steps) was recorded as the score for that climb. The cumulated rung scores for each 30-sec. period constituted the score for that trial period. It was emphasized that when balance was lost it was important to hold on to the ladder and start climbing again as soon as possible. An extra 30-sec. rest was given after the fifth trial, since some subjects tended to fatigue during the experiment.

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[2] This test was devised by the author.

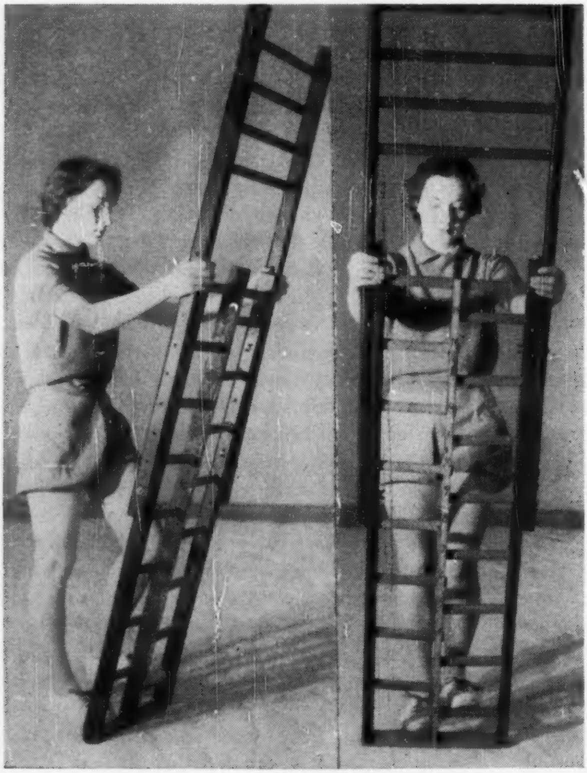

FIGURE II. Ladder Balance Apparatus.

In both experiments, the subjects were kept informed as to the score after each trial. No prepractice contact of any kind with either the stabilometer or the ladder was permitted. If it had been, the initial scores would have been of questionable value.

Subjects. Three hundred and twenty subjects, 160 male and 160 females, were tested on both the stabilometer and the ladder climb. There were eight male and eight female subjects in each of 20 single-year groups, which ranged from 6 to 26 years.[3]

The subjects were student volunteers. They were unselected insofar as factors which might be expected to influence motor performance were con-

[3] While the factual data will be presented in tables that differentiate the subjects with respect to sex and age, these variables are not of primary concern in the present study. A subsequent report will analyze in detail the role of sex and age in motor learning and performance.

cerned. They were obtained from Chico State College and from the public schools of Chico, California. College-age subjects were obtained from the student body as a whole, rather than just from the physical education classes.

Results

Reliability of Individual Differences. The reliability coefficients shown in Table 1 are the correlations between skill and initial trials 1 and 2, between final trials 9 and 10, and between the two learning scores (trial 1 minus trial 9, and trial 2 minus trial 10). It should be recognized that the estimated reliability of the individual differences is necessarily lower for learning than for initial or final scores, because a learning score is computed by subtracting the latter from the former, and any random error variances in the two measurements will be additive.

Significance of Learning. Learning scores for both sexes show that a highly significant amount of improvement took place in performance of both tasks. In the stabilometer task the t ratios for differences between initial and final trials or gain in performance (the learning scores) were $t = 30.4$ for trial 1 minus trial 9; and 24.0 for trial 2 minus trial 10 for all males. They were 30.1 for 1 minus 9, and 27.8 for 2 minus 10 for the females. The corresponding t ratios for the ladder climb were 24.1, 16.9 for males, and 25.6 and 19.5 for the females. Even for the age group with the smallest learning score on the stabilometer (males age 7), the t ratio was 3.76, which is significant at the 1 percent level.

TABLE 1.—RELIABILITY OF INDIVIDUAL DIFFERENCES[a]

Group	N	Stabilometer			Ladder		
		Learning	Initial	Final	Learning	Initial	Final
Age 6-11							
Male	48	.587	.860	.870	.578	.933	.944
Female	48	.804	.921	.965	.831	.935	.967
Age 12-18							
Male	56	.662	.830	.760	.803	.869	.734
Female	56	.724	.906	.931	.903	.856	.958
Age 19-26							
Male	56	.764	.876	.900	.746	.875	.879
Female	56	.595	.829	.896	.845	.870	.945
Age 6-26							
Male	160	.685	.902	.917	.791	.918	.935
Female	160	.745	.908	.943	.872	.904	.955
Mean[b]							
Male	160	.678	.857	.853	.720	.897	.878
Female	160	.719	.891	.937	.864	.893	.955

[a] All coefficients have been corrected to the full test values by the Spearman-Brown method.
[b] Average of the subgroup coefficients using the Z-transformation method.

Task Specificity. The cross correlations for learning and for performance for all three age groups and each sex are small even though fully corrected for attenuation. These correlations are shown in Table 2. Only the initial performance of males age 19-25 shows a correlation significantly different from zero. This is probably just an aberrant correlation such as might be expected occasionally among 18 correlations based on noncorrelated "true" relationships. The negative sign of this correlation shows that individuals who had good scores (low) on the stabilometer had poor scores (low) on the ladder climb task and vice versa. When this 19-25 year age group is divided into subgroups, the younger one (19-21 years, $N = 24$) shows a correlation of —.409, and the older one (22-25 years, $N = 32$) shows a correlation of .269. Neither is statistically significant.

Since the error variance has been removed from the correlations by the correction for attenuation, the correlation r is a measure of generality of abilities, uncontaminated by the influence of imperfect reliability. The coefficient of alienation k is related to r by the well-known mathematical definition $r^2 + k^2 = 1$. Thus k can be considered to be a measure (in correlation units) of the amount of specificity of abilities. Multiplying each term in the formula by 100 makes it possible to table the percentages of individual differences that are general, i.e., common to both motor tasks, and specific, i.e., unique to only one of the tasks. This has been done for the six subgroups in Table 3.

Discussion

The reliabilities of individual differences in performance, both initial and final, are relatively high in comparison with other coordination or kinesthesis tests (6). It is difficult to find data in the literature on the reliability of learning, when learning is defined as the improvement in performance resulting from practice in large-muscle motor tasks. The values obtained in this study may be considered fairly good, even though one would like to see them larger. It is doubtful if there is any alternative method of handling the scores that would be much better. It is possible that more reliable individual differences in learning might be measurable by fitting individual learning curves to the data. While this would be extremely laborious by conventional methods, the use of modern electronic computers may bring this method within the scope of practicality. It would be desirable to add two more trials to the practice period, since this would permit a more accurate estimate of the final skill level. If this is done, however, there may possibly be difficulties with fatigue and loss of motivation near the end of the experiment.

When all of the reliability coefficients of Table 1 (learning, as well as initial and final scores for each sex group) are averaged together for each task, it is found that the mean reliability for the entire group (age 6 to 26) is only 3 percent larger in each task than the mean reliability of the subgroups. This finding indicates that for these particular motor tasks, heterogeneity of age has not inflated the correlations.

TABLE 2.—CORRELATION BETWEEN STABILOMETER AND LADDER BALANCING ABILITIES

Group	N	Learning[a]	Initial[a]	Final[a]
Age 6-11				
Male	48	−.165	−.168	−.110
Female	48	.064	−.034	.049
Age 12-18				
Male	56	.052	−.170	−.065
Female	56	.042	−.130	.039
Age 19-26				
Male	56	−.003	−.424[c]	−.152
Female	56	.140	−.052	.249
Mean[b]				
Male	160	−.039	−.260[c]	−.111
Female	160	.082	−.072	.113

[a] The algebraic signs have been reversed for the coefficients of the initial and final scores, since high skill is represented by a low stabilometer score or a high ladder balance score. All correlations are based on the average of two trials per subject. The coefficients have been fully corrected for attenuation in both variables, using the reliability coefficients reported in Table 1.
[b] Average of the subgroup coefficients using the Z-transformation method.
[c] Significant at the 1 percent level.

TABLE 3.—SPECIFICITY VS. GENERALITY OF STABILOMETER AND LADDER BALANCING ABILITIES

Group	N	Learning		Initial Skill		Final Skill	
		Generality	Specificity	Generality	Specificity	Generality	Specificity
Age 6-11							
Male	48	2.71%	97.29%	2.83%	97.17%	1.20%	98.80%
Female	48	0.41%	99.59%	0.12%	99.88%	0.24%	99.76%
Age 12-18							
Male	56	0.27%	99.73%	2.88%	97.12%	0.42%	99.58%
Female	56	0.17%	99.83%	1.69%	98.31%	0.15%	99.85%
Age 19-26							
Male	56	0.01%	99.99%	18.00%	82.00%	2.32%	97.68%
Female	56	1.97%	98.03%	0.27%	99.73%	6.21%	93.79%

Both tasks are convenient and practical for testing members of either sex and for use with a wide range of chronological ages. No particular difficulty has been encountered, so far, with previous experience or practice in the skills involved, although this is potentially a menace in any learning experiment. The bongo board, in particular, might create a problem in some localities.

Neither task can be considered to measure the sense of balance. The stabilometer performance requires a large amount of almost continuous physical activity. The board does not remain stable, even for the final trials. Most of the large muscle groups are extensively involved. The balancing seems to

involve kinesthesis more than semicircular canal function. The improvement in performance is probably an improvement in muscular coordination; movements become precisely adjusted so that the board remains relatively stable. Extensive physical activity of the large-muscle type is also required for the ladder balancing task. Even the final trials involve considerable movement, since static positions are brief and rare. Success seems to be related to the development of complex, precise, and highly coordinated large-muscle movements dependent upon kinesthetic information. It would seem that both these tasks should be described as complex large-muscle coordinations.

The absence of correlation between individual differences in performance abilities for these two similar motor tasks, or between individual differences in learning abilities for the two tasks, will probably surprise some readers. Certainly the outcome seems to rule out the presence of general motor coordination ability in the ordinary usage of the term; it also rules out the presence of a motor learning ability. Instead, the abilities are task-specific, both for performance and for motor learning.

It would not be difficult to alter the experiment in such a manner that a pseudogeneral ability would appear. For example, suppose that instead of testing volunteer subjects individually with particular attention to maintaining insofar as possible, equal motivation for all, there had been compulsory participation by members of a school class. In this situation some individuals would be motivated to a high degree, some would simply go through the motions, and others would be intermediate. The consequence of this differential motivation would be a correlation between scores in the two tests, even though the true abilities were actually uncorrelated. Or suppose that we are testing two skills that have considerable correlation with age or maturity or growth. Unless the influence of these variables was carefully eliminated, a pseudogeneral ability would appear. In older subjects, a comparable situation would be obtained for tests in which body size or structure was correlated with performance. It follows directly from these considerations that the mere occurrence of positive intertask correlations, or for that matter the emergence of a general or group factor in a more complicated situation, does not overthrow the theory of task specificity unless statistically spurious elements in the experiment are eliminated.

Summary and Conclusions

Three hundred and twenty subjects were tested on two large-muscle motor tasks in order to investigate task specificity vs. generality in the initial performance and the learning of two large-muscle motor skills. In one task, the subject stood on a pivoted board (stabilometer) and attempted to keep in balance with a minimum of movement. In the other, he repeatedly climbed a free-standing vertical ladder as far as possible before it toppled over. Both tasks were novel and initially unpracticed. Each involved almost continuous motor activity even after the full amount of practice. Ten trials were given on each. Statistically significant learning was observed in

all age groups on both tasks; on the average it amounted to 59 percent improvement for the stabilometer and 44 percent improvement for the ladder climb.

Insofar as can be generalized from the two tasks investigated, motor learning is remarkably task-specific. No correlation was found that was significantly different from zero for any of the age groups. The greatest percent of communality of function was found in the 6- to 11-year-old boys; even in this case there was less than 3 percent of generality in learning the two tasks.

The results show little more than zero correlation between performance of the two tasks, and therefore substantiate the theory of task specificity of motor abilities. In the one instance out of 12 where a significant correlation was found, it was low, and its sign showed a negative relation between skills in the two tasks. Certainly one would have to be very optimistic to consider this evidence of a relationship of any importance.

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(Submitted 4/2/60)

Relationship between Level of Aspiration and Selected Physical Factors of Boys Aged Nine Years[1]

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Abstract

Utilizing a grip-strength test, 98 nine-year-old boys were asked to predict future performance on the basis of knowledge of past results on each of two succeeding endeavors with a hand dynamometer. Two aspiration discrepancy scores were computed and the subjects divided into three distinct groups: those with the highest positive scores, those with "zero" discrepancies, and those with the greatest negative scores. The differences between the means of these groups for various physical factors were tested for significance. Results indicated that boys who expressed higher levels of aspiration were physically superior in size and strength to those who expressed neither an increase nor a decrease in their assessments.

A TECHNIQUE OF individual personality evaluation seems to be offered in the use of level of aspiration testing. Introduced into experimental psychology by Hoppe (14), the concept of approaching certain environmental, personal, and social factors through the use of this procedure has suggested possibilities for improving understanding of human motivation, one of the difficult types of psychological assessment.

Review of Literature

Studies of level of aspiration and their application to generalized personality traits were quite evident in the literature of the late 1930's and early 1940's. Frank (7) studied tests of speed printing, spatial relations, and motor coordination (quoits); he concluded that level of aspiration represented a stable characteristic of personality. His further attempts at validation (6) showed that the average level of aspiration deviated more from the median level of performance than did the average guess. Gould (11) also found that the aspiration-level technique was identified with certain specific personality characteristics.

Gardner (9) obtained high intercorrelations between level of aspiration expressions on four mental tasks; he concluded that the behavior underlying these measures was

[1] This study was conducted with data obtained from the Medford, Oregon, Growth Study. Subsidization of the Growth Study was provided by Medford Public Schools, Southern Oregon College, Athletic Institute (Chicago, Illinois), and University of Oregon. Acknowledgments are further made to Robert H. Doornink and Boyd E. Morgan for their technical assistance in this study.

characterized by a considerable degree of generality. However, in studying individual differences in aspiration level and ratings on eight personality variables (10), his correlations were low and for the most part insignificant.

In general, experiments involving level of aspiration have utilized mental rather than physical tasks for test situations. Among others used in investigations are digit symbol substitution (8, 9, 10, 11, 12) and problems in arithmetic (11, 12, 19). Target throwing has also been used in some studies (1, 11, 12, 19). This test, of course, represents a coordination ability. These test situations appear simple enough to be performed by all subjects while still challenging their ability to improve on future attempts; such situations are needed in level of aspiration testing.

Only one published level of aspiration study has been related specifically to physical education. Smith (20) investigated the influence of football success and failure on the level of aspiration of the participants. His findings agreed with those of Jucknat (16) and Festinger (5), who worked with other types of activities, in that there was a tendency for successful players to raise their level of aspiration. Further, Smith found that individuals expressing higher levels of aspiration maintained some hope for success while repeatedly experiencing failure, and that those with low aspirations who experienced failure overtly withdrew from failure-producing situations. He also observed a tendency for those with the highest levels of aspiration to experience success repeatedly, even though they raised their level of aspiration goals. Smith concluded that the ultimate level of aspiration was not correlated with ultimate achievement.

Inasmuch as no study has investigated level of aspiration utilizing a measure of maximum strength or has examined its relationship to selected physical, motor, and maturity factors, such an investigation seems appropriate. This research was undertaken to shed additional light on the role played by physical factors when associated with the achievement of aspiration goals.

Methodology

Level of Aspiration Test

Level of aspiration, as defined by Frank (7), is "the level of performance on a familiar task which an individual undertakes to reach." It was determined in the present study with the use of a hand dynamometer designed to measure the maximum static strength of the hand-gripping muscles. Each subject was given this test, told of his results, and asked to predict what his next effort would produce. He was then given a second grip test. On the basis of his second performance, the subject was again asked to assess his next grip test. He was then given a final strength measurement. Two scores only were utilized in this study to assess level of aspiration, as follows:

1. *Discrepancy Score* 1 (DS-1). This score was assessed in accordance with the technique used by Boyd (2), which consisted of determining the difference between the first grip strength score and the first stated aspiration score. A positive value was recorded when the aspiration score was greater than the subject's preceding grip strength and a negative value was given when it was less.

2. *Discrepancy Score* 2 (DS-2). This discrepancy score was computed in the same manner as DS-1, except that each subject's second grip strength achievement and his second aspiration expression were utilized.

Experimental Variables

Maturity Assessment. Skeletal age was determined by assessing the X ray of the hand and wrist against the Greulich and Pyle standards (13).

Structural Measures. Body weight, standing height, flexed-tensed upper arm girth, hip width, McCloy's Classification Index I (17), and Wetzel Nutritional Channel (21).

Motor Test. Standing broad jump

Strength Tests (3, 4). Rogers' arm strength, McCloy's arm strength, Rogers' Strength Index, Rogers' Physical Fitness Index, and the mean of the following 12 cable-tension strength tests: elbow flexion, shoulder flexion, shoulder inward rotation, trunk flexion, trunk extension, hip flexion, hip extension, hip inward rotation, knee flexion, knee extension, ankle plantar flexion, and ankle dorsal flexion.

Subjects

The subjects were 98 nine-year-old boys in the Medford, Oregon, public schools. The tests were administered within two months of each boy's birthday.

Testers

Before collecting research data, the testers administered the anthropometric tests (upper arm girth and hip width), the standing broad jump, and all cable-tension strength tests twice to 30 subjects. The results of the two administrations of each test were then correlated to obtain objectivity coefficients. If the resultant correlation did not compare favorably with that established for a test, the testers continued to practice until a satisfactory degree of agreement between testers was realized. The correlation coefficients achieved for the cable-tension strength tests ranged from .87 to .99, which approximated those reported for these tests; those for the anthropometric measurements were in the high 90's. The tests comprising the battery for the Strength Index and Physical Fitness Index were administered by testers with extensive testing experience.

Treatment of Data

For each of the discrepancy scores (DS-1 and DS-2), the subjects were divided into three groups: those with the highest positive scores; those with zero, or no discrepancies; and those with the greatest negative scores. These were distinct groups with gaps in the distributions between them. Of the 98 boys included in the study, 48 and 54 were used in the three DS-1 and DS-2 groups respectively. The characteristics of these distributions of discrepancy scores were as follows:

	DS-1			DS-2		
	N	Mdn	Q	N	Mdn	Q
High Positive (High) Group	20	8.00	2.00	20	6.00	2.00
Zero Group	14	......	......	22	......	......
High Negative (Low) Group	14	—2.50	1.50	12	—3.50	4.50

The differences between the means of the high, zero, and low aspiration groups for the various physical factors were computed separately. These differences were tested for significance by application of the t ratio applied to uncorrelated groups. Significant t ratios at the .05 level ranged from 2.02 to 2.06 for the various degrees of freedom; at the .01 level, the range of significant t ratios was 2.70 to 2.78.

Results

Discrepancy Score 1. The results of the comparison of mean performances on the 13 experimental variables for the subjects expressing high, zero, and low aspiration goals for DS-1 appear in Table 1. A summary of these results follows.

1. *High vs. Low Discrepancy Groups.* The boys with highest DS-1's had significantly greater mean Physical Fitness Indexes (115.60) than those with lowest DS-1's (100.30). The difference between these means was 15.30. This difference is significant at the .05 level, since the t ratio is 2.21. None of the differences between the means for the other experimental variables was significant.

2. *High vs. Zero Discrepancy Groups.* When divided on the basis of high and zero DS-1's, several experimental variables exhibited differences between means. The differences between the means for the Physical Fitness Index and McCloy's arm strength score were significant at the .01 level; the t ratios were 2.90 and 2.82 respectively. The following four additional tests had differences between means which were significant at the .05 level and above: height, weight, McCloy's Classification Index, and Rogers' Strength Index.

3. *Low vs. Zero Discrepancy Groups.* None of the t ratios representing the difference between means for the various experimental tests was statistically significant when the low and zero DS-1 groups were compared.

Discrepancy Score 2. Table 2 contains the results from comparing the means on the experimental variables between boys achieving high, low, and zero levels of aspiration, as revealed by DS-2. None of the t ratios for either high vs. low, high vs. zero, or low vs. zero DS-2 groups was significant.

Summary and Conclusions

Two assessments of level of aspiration were made with the use of a hand dynamometer, and 13 physical, motor, structural, and strength tests were given to 98 nine-year-old boys. Two aspiration discrepancy scores were computed and the subjects were divided into three extreme groups: those with the highest positive scores, those with zero discrepancies, and those with the greatest negative scores. Mean differences for the various physical factors among these groups were computed and tested for significance. The following results were obtained:

1. The Physical Fitness Index, a test of muscular strength relative to each boy's age and weight, was the only test in which the differences between

TABLE 1.—DESCRIPTIVE STATISTICS AND T-RATIOS FOR EXPERIMENTAL VARIABLES BASED UPON DISCREPANCY SCORE 1

Variables	Discrepancy Score 1						t ratios		
	High		Low		Zero		High vs. Low	High vs. Zero	Low vs. Zero
	Mean	σ	Mean	σ	Mean	σ			
1. Height (in.)	53.20	2.75	52.34	1.81	51.17	1.61	1.06	2.64[a]	1.75
2. Weight (lbs.)	71.75	14.70	65.66	8.04	61.92	7.74	1.51	2.46[a]	1.21
3. Upper Arm Girth (cm.)	21.10	2.39	20.86	1.64	20.27	1.50	.34	1.20	.76
4. Hip Width (cm.)	21.23	1.72	20.74	1.31	20.27	1.38	.93	1.75	.90
5. Classification Index	160.80	13.88	155.02	10.31	152.04	6.90	1.35	2.36[a]	.87
6. Wetzel Nutritional Channel	5.05	2.00	5.27	1.54	4.56	1.44	—.35	.80	1.22
7. Rogers' Arm Strength	40.81	30.48	46.20	36.45	38.05	37.35	—.43	.22	.56
8. McCloy's Arm Strength	178.30	44.70	159.59	28.99	143.07	24.10	1.41	2.82[b]	1.58
9. Strength Index	768.30	158.08	695.60	134.80	665.45	131.39	1.40	2.01[a]	.58
10. Physical Fitness Index	115.60	20.61	100.30	18.18	98.15	13.29	2.21[a]	2.90[b]	.34
11. Cable-Tension Strength Test Average (lbs.)	45.96	10.11	41.23	8.11	41.50	6.08	1.46	1.56	—.10
12. Standing Broad Jump (in.)	51.80	8.31	49.70	5.15	50.51	6.91	.88	.48	—.34
13. Skeletal Age (mos.)	9.40	1.03	9.05	.95	8.90	.97	1.00	1.43	.39

[a] Statistically significant at the .05 level.
[b] Statistically significant at the .01 level.

TABLE 2.—DESCRIPTIVE STATISTICS AND T-RATIOS FOR EXPERIMENTAL VARIABLES BASED UPON DISCREPANCY SCORE 2

	Discrepancy Score 2						t ratios		
	High		Low		Zero		High vs. Low	High vs. Zero	Low vs. Zero
Variables	Mean	σ	Mean	σ	Mean	σ			
1. Height (in.)	52.75	2.43	52.08	1.88	51.55	1.87	.84	1.74	.76
2. Weight (lbs.)	68.15	9.62	63.97	6.44	63.18	10.37	1.42	1.57	.27
3. Upper Arm Girth (cm.)	20.81	1.73	21.20	1.65	20.30	1.89	—.61	.89	1.38
4. Hip Width (cm.)	20.96	1.20	20.98	1.30	20.49	1.34	—.04	1.18	1.00
5. Classification Index	156.90	10.30	154.50	9.95	152.27	10.13	.63	1.43	.60
6. Wetzel Nutritional Channel	5.25	1.04	4.75	.72	4.73	1.65	1.52	1.18	.05
7. Rogers' Arm Strength	38.89	25.41	45.17	23.11	42.64	29.12	—.68	—.43	.27
8. McCloy's Arm Strength	165.34	28.78	158.77	22.90	150.03	33.05	.68	1.55	.88
9. Strength Index	771.70	179.04	680.86	113.25	722.20	185.31	1.70	.86	—.78
10. Physical Fitness Index	110.90	21.68	100.00	15.32	109.10	24.54	1.61	.25	—1.29
11. Cable-Tension Strength Test Average (lbs.)	44.17	7.91	44.93	6.39	42.78	8.31	—.29	.53	.81
12. Standing Broad Jump (in.)	51.91	6.42	52.10	3.93	52.86	4.40	—.10	.54	—.50
13. Skeletal Age (mos.)	8.89	.95	8.96	1.22	9.14	.72	—.16	—.93	—.43

means were significant in more than one comparison of the aspiration groups. The boys in the high DS-1 group had a significantly higher Physical Fitness Index mean than did the boys in the zero and low DS-1 groups. However, significant differences between the means for this test were not obtained when the low and zero DS-1 groups were compared; also, none of the differences between the Physical Fitness Index means was significant for the comparison of the DS-2 groups.

2. The greatest number of significant differences between means on the various experimental tests was obtained when the high and zero DS-1 groups were compared. The differences on the following six tests were significant at the .05 level and above: height, weight, Classification Index, McCloy's Arm Strength, Strength Index, and Physical Fitness Index.

3. None of the differences between the means of the low and zero DS-1 groups and between the means of all DS-2 groups was significant. Further, the following tests were not significant for any comparison between level of aspiration groups: upper arm girth, hip width, Wetzel Nutritional Channel, Rogers' Arm Strength, cable-tension strength test average, standing broad jump, and skeletal age.

Apparently, the nine-year-old boy who strives to attain higher goals (expresses higher levels of aspiration) is physically superior in size and strength to others his age who are not willing to risk the chance of failure, and who thereby choose the aspiration level that seems to ensure at least some measure of continued success. It would seem that this technique does provide a means for studying the behavior of young boys, for their selection of level of aspiration appears to reflect the previous success or failure which they associate with the task. This has been represented in the present study by the grip strength test.

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Certification Requirements of Physical Education Teachers between 1953 and 1959

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Abstract

A total of 26 states made changes in the minimum requirements for certification of physical education teachers since 1953, with 14 states increasing the physical education requirement and one state reducing this requirement. There is no tendency toward uniformity indicated by these changes and no two states have adopted the same requirements.

TEACHER CERTIFICATION is the process used by the state to determine those persons who are eligible to accept positions as teachers within the boundaries of that state. There is a close relationship between teacher certification and teacher education. Improved teacher education programs make possible the raising of certification standards. While teacher certification sets standards, teacher education is a process whereby students are prepared to meet those standards. A good teacher education program prepares teachers who are professionally competent to perform the type of service defined in the certificate. The state legal agency defines the minimum standards to be met by applicants for certificates.

Purpose

The purpose of this study was to compare the minimum certification requirements for physical education teachers in the 50 states for the years 1953 and 1959 and to investigate trends. Similar studies were completed in 1942 by Morehouse and Schaaf (3), in 1948 by Morehouse and Aloia (1), and in 1953 by Morehouse and Miller (2).

The continuation study started in 1942 by Morehouse and Schaaf showed a lack of agreement among the state laws as to certification of physical education teachers. The desirability of uniform standards was expressed by state directors and faculty members of institutions who must design their curriculums to meet state requirements. Little progress was made toward this end, as indicated by the 1947 study by Morehouse and Aloia. Changes were recorded by 13 states in the physical education requirements. Seven states increased the requirement, three states reduced their standards, and three states altered their degree or course requirements. The study in 1953 by Morehouse and Miller again indicated that no progress had been made

toward adopting uniform standards although changes in the requirements were made by 19 states. The results showed that five states increased the requirements, three states reduced this requirement, and 11 states recorded changes in degree or course requirements.

Procedures

A letter requesting all pertinent information regarding the minimum certification for physical education teachers was sent to the State Department of Public Instruction of the 50 states. Replies were received from each of the states although follow-up letters were necessary in some instances.

After receiving the information, it was edited for conformity where necessary, and the interpretation was returned to each state to be verified. In this manner, an accurate list of the requirements for each state, edited for comparative purposes, was compiled.

Only minimum requirements were considered, and each requirement was listed in semester hours. Requirements in four general areas were considered: (a) degree requirement, (b) physical education requirement, (c) general education, and (d) professional education.

Results

The minimum requirements to become certified for full-time teaching of physical education have been changed by 26 states since May 1, 1953. A summary of the changes appears in Table 1.

In the area of professional education, 15 states made changes. Increases were recorded in nine states, while three states reduced this requirement. Since 1953 Iowa has eliminated the requirement, and Connecticut and Georgia have added the professional education requirement to become certified. The requirement in states having professional education requirements has increased from an average of 16.14 semester hours per state in 1953 to 17.66 semester hours in 1959.

General education requirements were changed in 12 states; in eight states requirements were increased and in two states they were reduced. Connecticut and Georgia have added this general education requirement since 1953.

The number of states with a general education requirement increased from 20 in 1953 to 25 in 1959. The general education requirement has increased from an average of 15.08 semester hours per state in 1953 to 19.76 semester hours in 1959.

Hawaii, Idaho, Oklahoma, and Texas have added the completion of a bachelor's degree to their requirements since 1953, leaving only Colorado and Maine as the remaining states that will certify a teacher who has not completed a degree program. Maine, however, has an alternate minimum requirement which does require a bachelor's degree for certification.

The physical education requirement has been increased by 14 states. Arizona is the only state to reduce this requirement.

TABLE 1.—CHANGES IN THE MINIMUM REQUIREMENTS IN SEMESTER HOURS FOR CERTIFICATION OF PHYSICAL EDUCATION TEACHERS

Change in requirements	State	1953	1959
PHYSICAL EDUCATION			
Increased physical education requirement	Alabama	12	18
	California	24	36
	Hawaii	0	24
	Idaho	12	18
	Indiana	18	24
	Iowa	26	30
	Maine	12	18
	Massachusetts	0	18
	Nebraska	15	18
	South Dakota	15	24
	Tennessee	14	24
	Texas	6	24
	Vermont	18	36
	Wyoming	15	24
Reduced physical education requirement	Arizona	30	24
Require a major in physical education	Minnesota	24	Major
Specific requirements to replace, completion of a four-year physical education program	Connecticut		35
PROFESSIONAL EDUCATION			
Increased professional education requirement	Alabama	18	24
	California	15	22
	Idaho	9	20
	Massachusetts	0	12
	New Mexico	16	24
	Oregon	12	14
	South Dakota	15	20
	Tennessee	18	24
	Texas	6	24
Reduced professional education requirement	Kansas	24	20
	Rhode Island	18	15
	Virginia	18	15
No specific requirement in 1953	Connecticut		18
	Georgia		20
No specific requirement in 1959	Iowa	24	

TABLE 1. Continued.

Change in Requirements	State	1953	1959
GENERAL EDUCATION	Alabama	30	36
Increased general education requirement	California	31	40
	Kansas	45	50
	New Mexico	0	48
	Tennessee	0	40
	Texas	0	45
	Virginia	36	42
	Wyoming	27	40
Reduced general education requirement	Ohio	45	30
	South Carolina	45	42
No specific requirement in 1953	Connecticut		40
	Georgia		40
DEGREE REQUIREMENT	Hawaii		
Bachelor's degree required in 1959	Idaho		
	Oklahoma		
	Texas		

The average physical education requirement for those states having certification requirements in 1953 was 21.22 semester hours per state. This average increased to 24.3 semester hours by 1959 or an average increase of 3.08 semester hours.

In 1953, eight states had a requirement of from 0 to 14 semester hours in physical education. Only one state having a requirement for certification now requires less than 15 semester hours. The number of states requiring from 15 to 24 semester hours has increased from 28 to 33, while those requiring 26 to 48 semester hours increased from 13 to 16 states.

There were three states with no requirements to teach physical education in 1953. Hawaii and Massachusetts have added this requirement, leaving only Alaska with no requirement for certifying physical education teachers.

State-by-State Summary of Changes

Alabama increased the physical education requirement by 6 semester hours, but did not specify courses to be included. The professional education requirement was increased 6 semester hours, and 6 semester hours of science were added to the general education requirement.

Arizona reduced the physical education requirement from 30 semester hours to 24. No course specifications were made.

California has completely revised the requirements necessary for certification and has added 12 semester hours to the physical education requirement, 7 semester hours additional professional education credits, and an increase of 9 semester hours in general education.

Connecticut, 1953, required the completion of an approved four-year teacher training course in physical education. In 1959, a bachelor's degree is required with a minimum

of 35 semester hours in physical education, 18 semester hours in professional education, and 40 in general education.

Georgia, in 1953, had no specific requirement in professional and general education. Today the requirement is 20 semester hours of professional education and 40 in general education. Specific courses are listed.

Hawaii would certify a teacher who had completed 18 semester hours of professional education in 1953. No degree was required. The requirement of a bachelor's degree and 24 semester hours in physical education has been added.

Idaho required 96 semester hours of credit, with 12 semester hours in physical education and nine in professional education in 1953. Idaho now requires a bachelor's degree with 18 semester hours in physical education and 20 in professional education. Specific courses are now required in these areas.

Indiana required 18 semester hours in physical education in 1953. This requirement has been increased to 24 semester hours.

Iowa has added 4 semester hours to the physical education requirement, bringing the total to 30. No specific courses are required. The 1953 professional education requirement of 24 semester hours was eliminated. The requirement now calls for completion of the required professional education courses of an approved institution.

Kansas decreased the professional education requirement from 24 to 20 semester hours and added 5 semester hours to the general education requirement which now totals 50.

Maine, in 1953, granted certification upon completion of three years of an approved four-year degree granting program in health and physical education. The certificate will also be granted in 1959. In 1953, certification would also be issued for an accredited bachelor's degree and 12 semester hours in physical education. The physical education requirement has been increased to 18 semester hours.

Massachusetts required a bachelor's degree or a diploma from a four-year normal school approved by the State Board of Education, plus evidence of sound moral character, good health, and American citizenship. This requirement now includes 18 semester hours in physical education and 12 semester hours in professional education.

Minnesota required 24 semester hours in physical education in 1953. The requirement is now stated as a major in physical education.

Nebraska has added 3 semester hours to the physical education requirement, bringing the total to 18. No courses are specified.

New Mexico increased the professional education requirement from 16 to 24 semester hours. The student teaching requirement was raised from 4 to 6 semester hours. A general educational requirement of 48 semester hours was added.

Ohio decreased the general education requirement from 45 to 30 semester hours of specified courses.

Oklahoma required 96 semester hours of college work in 1953. A bachelor's degree is now required.

Oregon increased the professional education requirement from 12 to 14 semester hours, specifying only 6 semester hours of supervised teaching.

Rhode Island required 24 semester hours of professional education courses approved for the preparation of special subjects teachers including Rhode Island education and not less than 6 nor more than 12 semester hours of practice teaching. The requirement now calls for 18 semester hours with the same specifications.

South Carolina decreased the general education requirement from 45 to 42 semester hours. One semester hour was eliminated from the health requirement and two from the art and music.

South Dakota increased the physical education requirements from 15 to 24 semester hours, with no course specifications. The professional education requirement was raised from 15 to 20 semester hours.

Tennessee increased the physical education requirement from 14 to 24 semester hours, the professional education area from 18 to 24 semester hours and added a general education requirement of 40 semester hours. Course specifications are made in each area.

Texas required 60 semester hours of college work with six semester hours in physical education and six in professional education. A complete revision of the standards now calls for a bachelor's degree with 24 semester hours in physical education, 24 in professional education, and 45 in general education. Courses are specified in professional and general education.

Vermont has added 18 semester hours to the physical education requirement, bringing the total to 36. This requirement is for teachers spending 80 percent or more of the school day teaching health and physical education.

Virginia added 6 semester hours to the general education requirement, bringing the total to 42 semester hours. The professional education requirement decreased from 18 to 15 semester hours.

Wyoming increased the standards in physical education and general education. The physical education requirement was increased from 15 to 24 semester hours and the general education requirement from 27 to 40 semester hours.

Discussion

There has been a general trend in the past two decades to increase the requirements for certification of physical education teachers. This process is slow, and it is not uniform. It may be that each state has its own separate guides which affect the setting of its own requirements and that each state expects to procure its teachers from its own teacher-training institutions. At present it would be a curricular impossibility for one teacher-training institution in the United States to prepare its physical education graduates for certification in all 50 states.

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Certification Requirements in Health Education, 1949-1959

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Abstract

This investigation, comparing statutes and regulations pertaining to certification requirements in health education in 1949 and 1959, disclosed an increase of these health education requirements for secondary school teachers in the 50 states and District of Columbia. The requirements involved general education, professional teacher education, and special teaching fields.

REQUIREMENTS for the teaching certificate, the license enabling the teacher to teach, are the minimum standards of teacher preparation. These requirements, which do not change frequently, are found in statutes enacted by state legislatures or in regulations established by state boards of education. Teacher certificating agencies are the official groups, authorized by state boards of education, to enforce the certification requirements.

These requirements are divided into three parts. The first part consists of general education, which provides the teacher with a broad cultural background. This may range from 20 to 60 semester hours.

The second part includes the professional teacher education requirements. These are the specialized courses in educational psychology, general curriculum and methods of teaching, history and philosophy of education, and student teaching. The range of teacher education requirements is usually from 12 to 24 semester hours. Occasionally, among these requirements are courses that deal with school-community health programs.

The third part indicates the specialized requirements of a teaching field, a major, or an area of concentration. For purposes of this investigation, the teaching fields are physical education, health and physical education, and school health education since these fields include health education as a part of the special requirements. The range of semester hours for these requirements is 12 to 60.

Sources of Data and Methods

Sources of data were statutes enacted by state legislatures, regulations established by state boards of education, and correspondence with teacher certification officials of each state and the District of Columbia.

In October 1949 and again in October 1959 certification requirements pertaining to health education were analyzed, checked, and compiled for each state and the District of Columbia. This investigation involved only teachers having bachelor's degrees.

Review of Related Studies

Previous to 1924, certification studies seldom mentioned health education in the requirements of secondary school teachers. From 1924-1959, general requirements in health education were more frequently indicated than were specific requirements.

In 1924, the U. S. Office of Education issued its first study of certification requirements for health education and physical education teachers in secondary schools (3). At that time, California, Connecticut, Florida, and Michigan offered certification in health education. Woellner and Wood (4) published the first digest of secondary school certification requirements in 1935. These digests, published annually, contain some reference to health education but generally deal with the over-all pattern of teacher certification. In 1942, Morehouse and Schaaf (2) revealed the minimum certification requirements in physical education but did not indicate the specific health education requirements in general education, professional teacher education, health and physical education, and school health education. Blesh (1) surveyed certification of health and physical educators in 1945. The general requirement was a major in health and physical education with a range of 10 to 60 semester hours. The minimum requirement most frequently mentioned was 24 semester hours.

The variations and extent of health education courses or areas required of the candidate seeking a secondary school teaching certificate in a particular state were omitted. For this reason, this investigation, which began in 1949, disclosed specific requirements in health education for secondary school teachers.

Findings

There are extensive variations in the state statutes and regulations pertaining to teacher certification, but the investigator has attempted to condense and summarize the specific requirements involving health education.

The findings of this investigation were divided into seven groups.

1. *Health education as a requirement in general education for the certification of secondary school teachers, 1949-1959.*

Nine states in 1949 listed health education, hygiene, or health in general education: Arkansas, Florida, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Nebraska, and South Carolina. The range of semester hours in health education was 2 to 3.

In 1959, 16 states included health education in general education: Arkansas, California, Florida, Illinois, Kansas, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, Ohio, Oklahoma, South Carolina, Tennessee, Virginia, and Washington. Six of these states stipulated health education or courses in health education as separate from other fields: California, Florida, Mississippi, Missouri, South Carolina, and Washington. Four of these six states designated 2.6 semester hours as the mean requirement in health education.

2. *Health education as a requirement in professional teacher education for the certification of secondary school teachers, 1949-1959.*

Two states in 1949 included health education as a part of the professional teacher education requirements: New Jersey and Utah. In 1959 five states recognized health education in professional teacher education: Arizona, California, Connecticut, New Jersey, and Utah. School-community health programs, health and safety education, and school health education were men-

tioned by these states. The *Utah Code Annotated*, 1943, stated, "Health education . . . shall be required of all teachers in the public schools of the state." This statement was applicable in 1949 and 1959.

3. *Health education as part of the special requirements for persons certified to teach secondary school physical education, in addition to general education and professional teacher education requirements, 1949-1959.* (See Table 1.)

Three states, omitted on Table 1, mentioned health education, but did not require or suggest any specific health education courses or areas and did not specify the total semester hours in health education. These states were California, 1949 and 1959; Idaho, 1959; and New Hampshire, 1949 and 1959. Within the ten years, there was a decrease in the number of states designating health education within the special requirements for persons certified to teach secondary school physical education. The mean required semester hours in health education was reduced from 5.28 in 1949 to 3.87 in 1959, even though the total semester hours in physical education remained fairly constant, 1949-1959.

4. *Health education as a part of the special requirements for persons certified to teach secondary school health and physical education, in addition to general education and professional teacher education requirements, 1949-1959.* (See Table 2.)

Ten states, not listed in Table 2, required health education but did not mention any specific health education courses or areas and did not specify the total semester hours in health education. These states were:

Delaware, 1959—45 semester hours of health and physical education
Georgia, 1959—30 semester hours of health and physical education
Illinois, 1949—32-36 semester hours in health and physical education
Kentucky, 1959—48 semester hours in health and physical education
Massachusetts, 1959—18 semester hours in health and physical education
New Mexico, 1959—36 semester hours in health and physical education
Oregon, 1959—30 semester hours in health and physical education
Rhode Island, 1949—24 semester hours in health and physical education
1959—40 semester hours in health and physical education
Texas, 1959—24 semester hours in health and physical education
Vermont, 1959—18 semester hours in health and physical education

In 1959 there were 21 states designating health education as a part of the special requirements for persons certified to teach secondary school health and physical education in comparison to 12 states in 1949. The mean required semester hours in health education was increased from 9.62 in 1949 to 10.1 in 1959, even though the total semester hours in health and physical education remained fairly consistent during the period.

5. *Health education requirements for persons certified to teach secondary school health education, in addition to general education and professional teacher education requirements, 1949-1959.* (See Table 3.)

TABLE 1.—HEALTH EDUCATION AS A PART OF THE SPECIAL REQUIREMENTS FOR PERSONS CERTIFIED TO TEACH SECONDARY SCHOOL PHYSICAL EDUCATION IN ADDITION TO GENERAL EDUCATION AND PROFESSIONAL TEACHER EDUCATION REQUIREMENTS, 1949-1959

State	Year	Health Education Courses or Areas Required or Suggested																				
		Total Physical Education Semester Hours	Total Health Education Semester Hours	Methods of Health Educ.	Hygiene and First Aid	School Health Program	First Aid	Hygiene	Personal Hygiene	Community Hygiene	School Health Education	Public Health	Child Hygiene	Immunology	Health and Safety	Safety Education	Sanitation	Health Educ. Materials	Physical Examination	Admin. of Health Educ.	Physical Inspection	Health Problems for School Child
Arkansas	1949	25	2												2							
	1959	25	2 or 3	x											2 or 3			x		x		
Colorado[a]	1949	30	6 2/3	2/3	4														2			
Iowa	1949	20	4			4																
Kansas	1949	40					x	x														
	1959	20	5				x	x														
Maryland	1949	30							x	x												
	1959	30					x		x	x												
New Jersey	1949	48					x		x	x						x						
	1959	40					x		x	x						x						
New York	1949	36					x									x					x	
	1959	36	4				1									1					2	
Ohio	1949	16-40	4-10	x					x		x	x	x	x			x					
Oklahoma	1949	24	2				2															
West Virginia	1949	24	4					x			x										x	
	1959	24	4																			4
Wisconsin	1949	30	12																			

Numbers indicate semester hours.
x indicates courses or areas required or suggested to complete total semester hours of health education.
[a] No bachelor's degree required.

TABLE 2.—HEALTH EDUCATION AS A PART OF THE SPECIAL REQUIREMENTS FOR PERSONS CERTIFIED TO TEACH SECONDARY SCHOOL HEALTH AND PHYSICAL EDUCATION IN ADDITION TO GENERAL EDUCATION AND PROFESSIONAL TEACHER EDUCATION REQUIREMENTS, 1949-1959

State	Year	Health Education Courses or Areas Required or Suggested																										
		Total Health & Phys. Educ. Semester Hours	Total Health Educ. Semester Hours	First Aid	Safety Education	Personal Hygiene	Community Hygiene	School Health Program	Hygiene	Nutrition	Mental Hygiene	School & Community Health	Physical Inspection	Methods of Health Educ.	Materials of Health Educ.	Child Hygiene	Sanitation	Immunology	Public Health	Health Education Content	Health Exam. and Follow-up	Family Life Education	Problems in Health Educ.	Principles of Health Educ.	Communicable Disease Control	Evaluation	Org. and Admin.	Medical Care
Hawaii	1959	36	12											x														
Indiana	1949	40-60	15-22.5	x	x	x	x	x																				
	1959	40	15	1	1	1	1	2																				
Louisiana	1949	41	6																									
	1959	33	7	1																								
Mississippi	1949	30	15	x	x				x	x	x	x	x	x	x							3						
	1959	30	15	x	x				x	x	x	x	x									x						
Missouri	1949	24	0																									
	1959	24	8																									
North Carolina	1949	30	5-7			x								x	x	x	x	x	x									
	1959	36	7-11	x	x																		x	x	x	x		
Ohio	1959	24	7		x	x	x	x		x	x			x	x							x			x	x	x	x
Oklahoma	1959	30	8																									
Pennsylvania	1949	30	10																									
	1959	30	10																									
South Carolina	1949	24	3-4	x	x	x	x																					
	1959	24						3																				
Tennessee	1949	14	6	x	x					x										x	x							
	1959	24	12	x	x	x				x	x					x						x			x			
Utah	1949	40	12																									
Virginia	1949	12	0																									
	1959	30	8	x	x			x						x	x													

Numbers indicate semester hours.
x Indicates courses or areas required or suggested to complete total semester hours of health education.

TABLE 3.—HEALTH EDUCATION REQUIREMENTS FOR PERSONS CERTIFIED TO TEACH SECONDARY SCHOOL HEALTH EDUCATION IN ADDITION TO GENERAL EDUCATION AND PROFESSIONAL TEACHER EDUCATION REQUIREMENTS, 1949-1959

State	Year	Health Education Courses or Areas Required or Suggested																										
		Total Health Education Semester Hours	Mental Hygiene	Health Counseling	Family Life Education	Foods	Nutrition	Maternal and Infant Health	Home Nursing	Personal Hygiene	School Health	Community Health	Safety Education	Occupational Hygiene	Org., Admin., Supervision of School Health Program	Principles, Methods, Materials	Problems Secondary School Health	First Aid	Elementary School Health Prog.	School and Community Health Prog	Secondary School Health Prog.	Evaluation	Communicable Disease Control	Sanitation	Exceptional Child	Driver Education	Public Health	Medical Care
California[a]	1959	36	x		x		x			x	x	x	x	x														
Connecticut	1949	18													x	x	x											
	1959	35		x	x	x	x			x		x	x		x			x										
Florida	1949	30	x	x	x		x	x	x	x	x	x	x		x	x		x	x	x	x							
	1959	30	x	x	x		x	x	x	x	6	x	x		x	x		x	x	x	x	x				x		
Idaho	1949	15																										
Illinois	1959	16																										
Indiana	1959	40	x				2			2	2	2	2					2					x			2	x	
Louisiana	1959	19									6		2		4			1										
New Jersey	1949	48	x	x	x	x	x			x		x	x		x	x		x										
	1959	40	x	x	x	x	x			x		x	x		x	x		x										
New York	1949	36	x	x	x	x	x		x	x	x	x	x		x			x										
	1959	36	x	2	2	x	x		x	x	x	x	1		2			1				x						
North Carolina	1959	24	x		x					x	x		1.5					1.5		3-6							x	
Ohio	1959	24	x		x		x			x		x	x		x	x					x	x	x		x	x		x
Tennessee	1959	16	x		x	x	x			x			x					x					x	x				

Numbers indicate semester hours.
x indicates courses or areas required or suggested to complete total semester hours of health education.
[a] Bachelor's degree plus 30 graduate hours.

In 1949 five states certified persons to teach secondary school health education in comparison to 11 states in 1959. The mean required semester hours decreased from 29.4 in 1949 to 28.7 in 1959, due to the increased number of states providing this type of certification. Of the suggested courses or areas in 1959, safety education was mentioned in ten states, school health in six states.

6. *Health education as a part of a special endorsement or as a requirement for secondary school teachers of the biological sciences, 1959.*

Hawaii gives a specialist's endorsement, "Qualified School Health Coordinator," for teachers who have qualified for special fields, have two years of regular teaching experience, and have completed certain requirements in health education for the endorsement.

Since 1954, Indiana has required three semester hours in health or first aid and safety among the 40 semester hours of the biological sciences.

Kentucky, in 1959, indicated that biology and health, as a major field, may be chosen by applicants for high school teaching certificates. Not less than eight semester hours shall be in biology or health within the major.

Since 1950, Missouri has certified biology teachers, grades 7-12, to teach health education if the biology teacher had eight semester hours of health education and physiology in addition to other requirements.

7. *District of Columbia and states providing certification for secondary school teachers but not indicating health education as a requirement in a specialized field, 1959.*

Within this group, there are four categories. Nine states and the District of Columbia provided certification for secondary school physical education teachers but did not include health education as a requirement in the specialized field: Connecticut, D. C., Florida, Illinois, Iowa, Kentucky, Louisiana, Minnesota, Nevada, and Wisconsin. Table 3 reveals that Connecticut, Florida, Illinois, and Louisiana provided certification for teachers of health education in secondary schools.

Eight states designated a teaching major, with required number of semester hours, but did not indicate physical education, health and physical education, or school health education as the teaching major: Alabama, Arizona, Michigan, Montana, Nebraska, Utah, Washington, and Wyoming.

Four states stipulated a four-year degree but made no mention of the required number of semester hours in the teaching major: Alaska, Colorado, North Dakota, and South Dakota.

Maine indicated the completion of a four-year degree in health and physical education but made no inclusion of the required number of semester hours.

In 1959, 13 states and the District of Columbia did not recognize health education in general education, professional teacher education, or in the special fields.

Summary

This investigation has revealed the increase in specific requirements in health education and the variations of these requirements for certification of secondary school teachers in the 50 states and District of Columbia, 1949-1959. These requirements were found in the general education and professional teacher education requirements for all secondary school teachers, in addition to the requirements for persons certified to teach physical education, health and physical education, or school health education. Increase in the acceptance of health education was found in general education, health and physical education, and, to some extent, in professional teacher education. For teachers of health education in secondary schools, specific courses or areas in health education were required or suggested, thus indicating that teachers of health education have been certified for their specialized preparation separate from physical education, health and physical education, and the biological sciences.

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Effect of Different Lengths of Practice Periods on the Learning of a Motor Skill

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Abstract

Three groups of junior high school boys learned the skill of mirror tracing on different practice schedules. All groups practiced two days per week for five days. One group practiced two circuits, the second group practiced five circuits, and the third group practiced eight circuits, on each practice day. Long practice periods proved advantageous during the early stages of the learning process. After the third practice period, however, groups using short practice periods improved just as much as groups using longer practices. A significant positive correlation was found between general intelligence scores and performance in the mirror tracing skill.

THE ULTIMATE PURPOSE of the research herein reported is an improvement in methods of scheduling practices for regular physical education activities. This study was an exploration of the effect of time and practice on the learning of a motor skill. Specifically, the merits of relatively long and short practice periods were sought.

In the realm of time psychology there are two prime considerations for most efficient learning: (a) the spacing or distribution of practices, and (b) the length of each practice period. Considerable research has been done regarding the distribution of practices. The consensus is generally made that some type of distributed practice schedule is advantageous over a massed or concentrated practice schedule (3, 4, 5, 10, 11, 14). Further, there is some evidence that relative massing during the early stages, with later distributed practices, shows advantages over other types of schedules (4, 6, 11).

This study was concerned primarily with the length of the practice period, an area in which research has been lacking. The skill used was mirror tracing, a laboratory type of motor skill. This type of skill, rather than a more common activity, was selected so that those variables which might affect one's performance (previous experience, practice during experiment, coaching, etc.) could be effectively controlled.

The apparatus used was the stabilimeter, which was developed and used extensively by Snoddy (13) and later by Lorge (10) and Massey (11). With this apparatus the subject looks into a mirror while tracing a star-shaped path. The front and back relationship appears reversed while left and right remain unchanged. The factors of speed and accuracy are brought into the performance score. The unique advantage of this skill is that it is a new experience for subjects, and therefore, all begin at a low level of performance.

Procedure

One hundred and thirty-five junior high school boys completed this experiment. The range in ages was from 12 to 15, with a mean age of 12.9.

The subjects were divided into three experimental groups, equated on the basis of performance scores made during the week prior to the beginning of regular practices. The equating process involved arranging all subjects according to height of performance score. Subjects were then assigned systematically to the three groups. The order of assignment was reversed after each three subjects. No significant difference existed among the groups following the completion of this process.

All groups practiced the skill of mirror tracing two days per week for five weeks. The two practice days were separated by one day. These distributed practices were used in order to guard against any inhibitory potential. The amount of practice during each practice period varied with each group.

The daily practice schedule varied with each group as follows: (a) one group (47 subjects) practiced two circuits on each practice day; (b) the second group (44 subjects) practiced five circuits on each practice day; (c) the third group (44 subjects) practiced eight circuits on each practice day. A circuit is completed when the subject traces around the star-shaped path once. For the ten practices, therefore, one group completed 20 circuits, another group 50 circuits, and the third group 80 circuits. The groups will be referred to as the 2-circuit, 5-circuit, and 8-circuit groups respectively. Emphasis was placed on the number of repetitions rather than the length spent in practice.

A retention test was given three weeks after the final practice to determine which group retained a greater proportion of the attained skill. The experimental period for each subject, therefore, covered a nine-week period.

On the equating day each subject practiced five circuits on the stabilimeter, and the best of these five was used as the criterion for equating the groups. At the retention test also, all subjects practiced five circuits.

A system of rest periods was used in order to guard against fatigue. Progressively increasing rest periods (by multiples of ten seconds) were inserted after each circuit. The scoring technique used included both speed and accuracy. The time (in number of seconds required to trace around the star) and errors (number of times the subject touched the edge of the path) were combined to obtain the raw score. These two factors were used so that the subject would not devote undue attention to one or the other.

As subjects improved in this skill the raw score decreased. In order to obtain increasing scores or a growing learning curve, the recriprocal of the raw score was multiplied by 1000. The result is a "conductance score" or C score, which is used in all tables. Each subject's daily practice score is the mean of all circuit scores on that practice day. The group practice score is the mean of all individual scores in the group.

A second purpose of this study was to determine the relationship between general intelligence and performance in this motor skill. Intelligence quotients

on the Pinter Intermediate Test (Form A) (12) were obtained for all subjects. These scores were correlated with the subject's performance in the mirror tracing skill throughout the experiment.

Analysis of Data

Performances of the three experimental groups were compared by statistical analysis at all phases of the study. Over-all group performances were analyzed by using a multiple analysis of variance. The statistical design used is described by Edwards (5). The particular model used is designed to analyze differences among any number of groups when repeated trials or practices are made by subjects in each of the groups. Scores were computed for groups, trials, subjects, interaction, residual, and total. By completing this analysis of variance, multiple classification, and F ratio was obtained. The size of this ratio indicated whether differences among the groups were significant. In this study, differences were considered significant at the 5 percent level of confidence.

Table 1 presents the group practice scores for the equating day, all practices, and the retention test. All groups improved with each practice period. None of the groups reached a plateau. Figure I illustrates the relationship of the groups to each other at all phases of the learning period.

Inspection of the data seemed to indicate that differences in group performance were greatest during the early practice periods. For this reason statistical comparisons were made among the groups for (a) practice periods one and two, (b) practice periods three and four, (c) practice periods five through ten, and (d) the retention performance. For each of these periods an analysis of variance was made to determine if there was a significant difference among the over-all performance levels of the groups (referred to as group

TABLE 1.—MEAN DAILY PERFORMANCE SCORES AND STANDARD DEVIATIONS FOR THE THREE EXPERIMENTAL GROUPS ON ALL PRACTICE DAYS

	2-circuit group (N = 47)		5-circuit group (N = 44)		8-circuit group (N = 44)	
Practice Day	Mean	SD	Mean	SD	Mean	SD
Equating	4.1	1.3	4.1	1.3	4.2	1.2
1	7.5	1.8	8.8	2.1	9.6	1.9
2	9.5	1.7	11.8	2.5	13.2	2.9
3	11.2	2.0	13.3	2.5	15.4	3.4
4	12.5	2.0	14.8	2.8	16.8	3.5
5	13.1	2.0	15.8	2.9	17.5	3.5
6	13.9	2.5	16.6	2.9	18.2	3.3
7	14.4	2.3	17.0	2.7	18.7	3.1
8	14.8	2.2	17.9	3.6	19.4	3.1
9	15.1	2.3	18.1	3.2	19.7	3.3
10	15.7	2.7	18.4	3.6	20.3	3.1
Retention	17.0	2.2	18.9	3.3	20.7	3.0

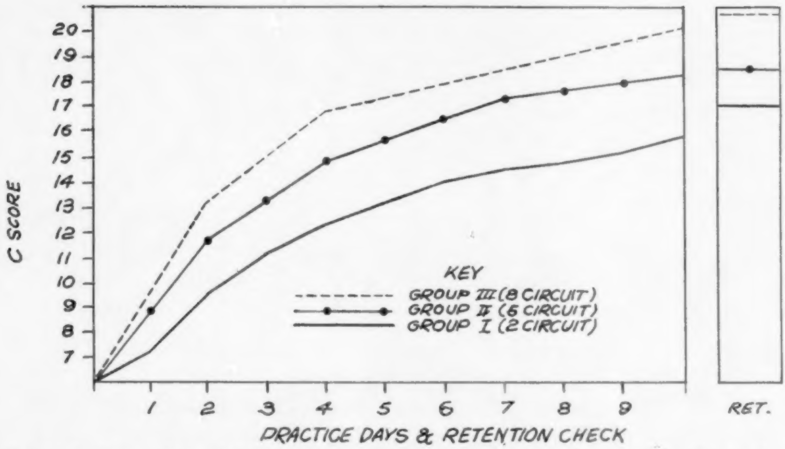

FIGURE I. Comparison of Group Performances on All Practice Days and the Rentention Check.

variance) and if there was a difference among the groups in the rate of improvement (referred to as interaction).

During practice periods one and two, there were significant differences among the groups in the level of performance. The 8-circuit group performed highest, with the 5-circuit group and the 2-circuit group following in that order. There were also significant differences in the degree of improvement shown by the groups.

During practice periods three and four, the groups remained in the same relative order. The differences among the groups in level of performance were significant. There were no differences among the groups, however, in numerical gains during this period. In other words, the F ratio for interaction was not significant.

The groups were compared for all practices from five through ten. There remained a difference in the level of performance; the order was the same as indicated above. There was no significant difference among the groups in the rate of improvement during this period. At the retention check, all groups performed better than they did at the tenth practice. Again there was a difference in the level of performance but no difference in the degree of improvement.

Tables 2, 3, and 4 show increments and decrements from circuit to circuit during each practice day and between practice days. Averages for these circuits are included in Table 1 and are illustrated in Figure I. Groups generally improved from circuit to circuit throughout the practice day. After the fourth practice, the high level of skill exhibited by the 8-circuit group late in the practice period is not retained at the following practice. Generally, the longer the practice period the greater was the loss in efficiency between practices.

TABLE 2.—MEAN DAILY CIRCUIT SCORES FOR THE 2-CIRCUIT GROUP IN ALL PERFORMANCES

Practice Day	Circuit 1	2	3	4	5
Equating	2.3	3.6	4.3	5.0	5.4
1	7.0	8.0			
2	9.0	9.9			
3	10.9	11.5			
4	12.1	12.8			
5	12.9	13.3			
6	13.7	14.1			
7	14.2	14.7			
8	14.6	15.0			
9	14.6	15.6			
10	15.6	-15.8			
Retention	16.2	16.7	17.4	17.0	17.5

TABLE 3.—MEAN DAILY CIRCUIT SCORES FOR THE 5-CIRCUIT GROUP IN ALL PERFORMANCES

Practice Day	Circuit 1	2	3	4	5
Equating	2.1	3.4	4.3	5.0	5.5
1	7.1	8.3	9.0	9.8	10.0
2	10.5	11.4	12.0	12.2	12.8
3	12.2	12.7	13.6	13.7	14.4
4	14.2	13.9	15.0	15.4	15.6
5	15.3	15.8	16.0	15.8	16.3
6	15.7	16.1	16.8	16.7	17.1
7	16.2	16.8	17.3	17.2	17.6
8	16.7	17.4	18.0	18.6	18.8
9	17.4	17.2	18.5	18.8	18.7
10	17.9	18.1	18.3	18.4	19.4
Retention	18.6	18.6	18.5	19.3	19.5

TABLE 4.—MEAN DAILY CIRCUIT SCORES FOR THE 8-CIRCUIT GROUP IN ALL PERFORMANCES

Practice Day	Circuit 1	2	3	4	5	6	7	8
Equating	2.3	3.8	4.3	4.9	5.6			
1	7.2	8.3	9.0	9.6	10.0	10.4	10.8	11.5
2	11.8	12.4	12.7	13.3	13.3	13.7	14.1	14.8
3	13.6	14.7	15.3	15.4	15.7	15.9	16.5	16.3
4	15.6	16.1	16.4	17.0	17.1	17.2	17.8	17.4
5	16.9	16.9	17.6	17.3	17.1	17.6	18.2	18.5
6	17.6	17.3	18.1	18.6	19.5	19.0	19.3	19.3
7	17.7	17.9	17.9	18.4	18.4	19.0	19.7	20.4
8	17.8	18.6	18.6	19.2	19.8	20.1	20.6	20.7
9	19.3	18.8	18.8	19.5	20.1	20.0	20.2	20.8
10	18.9	19.4	20.2	20.8	20.9	20.5	20.5	20.9
Retention	20.0	20.5	20.8	20.9	21.2			

Table 5 includes Pearson product-moment coefficients of correlation between each subject's general intelligence score and his performance in the mirror tracing skill. Each subject's daily performance score was used as a basis for correlation. Correlation values reported in the table are averages for the 135 subjects. The level of significance for these correlations were obtained by referring to the Wallace-Snedecor Table (5). With 132 degrees of freedom, r's became significant at .17 and .22 for the 5 percent and 1 percent levels of confidence respectively. All correlations listed in Table 5 are positive. Although most of these correlations are significant, they are too low to be of great predictive value.

Certain early performances were compared with later performances to determine if the skill exhibited by a person early in the experimental period gave any indication of his later performance. Table 6 includes these coefficients of correlation. All correlations are positive and each is significant. It can be noted that generally the closer two performances are together, the greater the correlation. Very early performance scores do not correlate as highly with future performance as do late performance scores. Mean perfomance scores obtained in the later stages of the learning process are more consistant with each other than are earlier performances. Performance scores at the second or third practice, however, appear to be a valuable index of one's future performance in this skill.

Summary and Conclusions

During the early stages of the experiment, the groups using relatively long practice periods showed advantages over the groups using shorter practices. After a degree of skill had been established, however, groups with short

TABLE 5.—CORRELATION OF GENERAL INTELLIGENCE SCORES WITH MEAN PERFORMANCE SCORES IN THE MIRROR TRACING SKILL FOR ALL SUBJECTS INCLUDED IN THE STUDY

Practice Day	Correlation of Performance Score with IQ Score
Equating	.13
1	.19[a]
2	.20[a]
3	.18[a]
4	.22[b]
5	.19[a]
6	.15
7	.24[b]
8	.22[b]
9	.15
10	.16
Retention	.22[b]
Mean	.19[a]

[a] Indicates significance to the 5 percent level of confidence.
[b] Indicates significance to the 1 percent level of confidence.

TABLE 6.—INTERCORRELATIONS OF DAILY MEAN PERFORMANCE SCORES IN THE MIRROR TRACING SKILL FOR ALL SUBJECTS INCLUDED IN THE STUDY

Practice Day	Equating	1	2	3	4	5	6	7	8	9	10
1	.61										
2	.35	.79									
3	.34	.76	.88								
4	.34	.73	.83	.90							
5	.35	.74	.82	.87	.89						
6	.31	.70	.81	.85	.87	.89					
7	.28	.69	.80	.86	.88	.85	.87				
8	.29	.72	.82	.84	.84	.86	.87	.89			
9	.25	.67	.79	.82	.81	.81	.84	.86	.89		
10	.25	.65	.73	.79	.87	.87	.82	.87	.86	.87	
Retention	.31	.64	.74	.78	.80	.81	.80	.82	.85	.83	.85

practices improved just as fast as groups with longer practices. In learning the skill of mirror tracing, therefore, relatively long practices are desirable during the early phase of the learning process. Further research is needed to explore the potentialities of progressively decreasing lengths of practice periods as one improves in this skill.

After considerable skill had been developed, efficiency which was exhibited late in the practice period was not carried over to the next practice. Dropping down between practices was especially apparent with the 8-circuit group. A high level of efficiency exhibited late in a long practice period, therefore, is not reliable in the mirror tracing skill..

All groups showed improvement at the retention check. This seems to indicate that some learning takes place during the rest period and that deterioration of this skill is relatively slow.

There was a significant positive correlation between general intelligence (as measured by the Pinter Intelligence Test) and performance in the mirror tracing skill. Subjects with high intelligence quotients generally performed better at all stages of the experiment than did those subjects with a lower intelligence quotient. Correlations among performance scores were higher than correlations between intelligence scores and performance scores. Early performance score in a new motor skill is therefore a better index of future performance than is the intelligence quotient.

The distributed practices and progressively increasing rest periods employed in this study effectively controlled any possible inhibitory potential or fatigue. Statistical comparison of the groups after 20 circuits reveals that there is no significant difference among the groups, regardless of the period in the experiment. No claim is made, however, that this is the best rest procedure for learning the mirror tracing skill.

A great deal more research is needed, especially where a laboratory type motor skill, as was used in this study, is combined with a meaningful physical

education skill. With more research it is certainly conceivable that specific recommendations can be made in regard to the number of repetitions during each practice period for maximum learning of baseball, free throw shooting, forward passing, or any other motor skill. It is likely that these recommendations will vary at different phases of the learning process.

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Simultaneous vs. Separate Bilateral Muscular Contractions in Relation to Neural Overflow Theory and Neuromoter Specificity[1]

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Abstract

The dynamometer strength of 30 males age 21 years was measured for each hand. There were two trials under the condition of single-hand contraction and two trials with simultaneous contraction of both hands. Facilitation as predicted by the hypothesis failed to occur. The dominant hand showed 3 percent loss of strength when there was simultaneous contraction of the contralateral hand, but there was no influence on the strength of the nondominant hand. Individual differences in strength were found to be 54 percent specific to the hand tested; there was only 46 percent general hand strength ability.

Review of Literature

In 1890 Binet observed that when the two hands make the same movements, there is mutual facilitation rather than interference (cited in 5, p. 709). Scripture, Smith, and Brown (5) demonstrated in 1894 that as a result of exercising the gripping muscles of one hand, there was a related increase in the strength of the other hand. Davis (1) in 1899 theorized that the increase in strength was the result of an "overflow" of nervous impulses, spreading and thus affecting the motor centers which deliver impulses to the unexercised limb. This theory is commonly accepted today.

During the past 20 years there have been scattered studies of this cross-transfer effect. These reflect differences in results and opinion among the investigators as to the amount of the effect and the nature of the necessary conditions. A recent report by Gregg, Mastellone, and Gersten (2) has summarized most of the recent findings regarding cross transfer, including the electromyograph studies.

Specificity vs. generality of neuromotor coordination abilities is a topic of current research interest. Henry and Whitley (3) have recently presented evidence which they interpret to mean that individual differences in a maximal static muscular contraction (such as is observed during a strength measurement) are determined by highly specific neuromotor coordination patterns. It would seem to follow logically from their concept that even simple bilateral motor acts should exhibit a large amount of neuromotor specificity. Lotter (4) has reported that in the case of a standardized arm movement made with maximal speed, there is 36 percent general arm speed ability and 64 percent speed ability that is specific to the right or left arm. He also found a large amount of bilateral neuromotor specificity in the speed of leg movements.

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[1]From the Research Laboratory of the Department of Physical Education. This study was supported by the Berkeley Faculty Research Fund of the University.

Problems Investigated

The writers have been curious as to whether the maximum force that can be exerted by a group of intact muscles (as measured, for example, with a hand dynamometer) would be influenced by the simultaneous maximal contraction of the muscles in another limb. No previous research on this problem has been located.

It might be hypothesized from the cross-transfer theory of Davis and others that there would be reinforcement of the contraction in one limb by the neural overflow created by the enervation of the other limb. Expectation of positive results is supported indirectly by an experiment performed by Vallerga (6). He found that increasing the neural inflow to the motor centers by using stronger sensory stimuli increased the measured hand dynamometer strength.

In regards to bilateral neuromotor specificity, it is of course a simple matter to compute the correlation between the observed hand grip strengths of the two limbs and correct it for the attenuation caused by unreliabiliy.

Method

The hand grip strength of 30 male undergraduates was tested with two Smedley dynamometers. These instruments were labeled; one was used for the dominant (preferred) hand and the other for the nondominant hand. Test 1 involved two conditions. The first condition involved the simultaneous maximal contraction of the two hands. The second condition involved the separate maximal contraction of the individual hands, the nondominant being measured last. There was a rest of three to four minutes between each measurement. Test 2 involved the same two conditions but was performed in an inverted order as to the sequence of measurements.

Th dynamometers were calibrated against standard weights. Grip distance was adjusted to individual subject preference but remained constant for each subject during all measurements. The arm was kept extended straight downward but did not touch the body. An effort was made to keep motivation and test conditions constant. The dominant hand was operationally defined as the one with the greater strength as measured. One measured contraction of a hand was considered a trial, regardless of the condition (single or simultaneous).

Results and Discussion

Single vs. Simultaneous Contractions. In the case of the dominant hand, the single contraction condition results in 3 percent greater muscular force than is the case when the condition involves simultaneous contractions by both hands (see Tables 1 and 2). The F value, 14.05, is far above the level required for statistical significance. The significant interaction of test x conditions emphasizes the wisdom of the balanced ab-ba design of the experiment; the "true" single vs. simultaneous difference is obtained by averaging the two tests and evaluated statistically in the variance analysis by the

TABLE 1.—STRENGTH IN KILOGRAMS

Tests		Dominant		Nondominant	
		Single	Simultaneous	Single	Simultaneous
Test 1	M	62.9	62.2	47.7	48.0
	σ	9.28	8.82	5.86	6.32
Test 2	M	64.1	61.1	47.8	48.1
	σ	8.16	8.56	6.46	7.19
Average		63.5	61.7	47.8	48.1
Simultaneous Minus Single			—1.8		+0.3

TABLE 2.—VARIANCE ANALYSES

Source of Variance	df	Dominant		Nondominant	
		MS	F	MS	F
Total SS	119	78.064	......	42.291	......
Subjects	29	274.76	28.27[b]	137.00	13.21[b]
Conditions	1	136.53	14.05[b]	4.62	0.45
subj. x cond.[a]	29	9.72	0.95	10.37	1.32
test x cond.	1	50.69	4.95[b]	0.01	0.00
Test	1	0.03	0.00	0.21	0.00
subj. x test	29	18.63	1.82	18.14	2.31[b]
Second order interaction	29	10.24	......	7.86	......

[a] Error term for subjects and for conditions.
[b] Significant at the 5 percent level.

main effect "conditions." As stated above, it is significant for the dominant hand. In regard to the nondominant hand, there is no evidence of any difference between single hand strength and simultaneous contraction hand strength. The difference is only a fraction of a percent and definitely within the limits of sampling error. The F ratio is only 0.45 compared with the value 4.18 required for significance at the 5 percent level.

The fact that strength is remarkably constant in the nondominant hand, regardless of test or condition (see Tables), is interpreted to mean that such possible factors as practice or fatigue are not of much importance here, although they must be balanced out in the dominant hand in the present type of experiment. It is inferred that the results for the dominant hand probably represent a real tendency for the single contraction to be stronger than the simultaneous contraction.

The results, therefore, are inconsistent with the hypothesis derived from the Davis neural overflow theory. This does not mean that the theory is invalid for the cross-transfer situation. That is a different problem. His theory was developed for that problem; the present study has been concerned with its application to another situation where it seemed to suggest a reasonable hypothesis.

No satisfactory theoretical explanation of the observed results is presently at hand. It could be suggested that the effect is caused by a division of attention during the simultaneous contractions, but that would seem to be inconsistent with the absence of the effect using the nondominant hand.

Bilateral Neuromotor Specificity. The results are given in Table 3. Individual differences in strength are fairly reliable, as shown by the substantial size of the correlations between single trials within a condition and the correlations between the average of two single trials by one of the hands and the average for two trials made by that hand under the condition of simultaneous contractions. It is interesting that the single trial reliability coefficients, when corrected by the Spearman-Brown method to the two-trial values, agree very well with the reliability coefficients computed directly from the average of two trials.

The bilateral correlations are statistically significant, since they are higher than the critical value of $r = .361$ for the 5 percent level of confidence. Table 3 also gives the values of the bilateral correlations after they have been corrected for attenuation caused by unreliability, using the usual method of dividing by the square root of the product of the reliability coefficients for single trials (.820 and .768) or two trials (.931 and .861).

As shown in Table 3, the bilateral correlations thus corrected have been used to compute the squared coefficients of alienation k^2, using the standard algebraic definition $k^2 = 1 - r^2$. As pointed out by Lotter (4), when the error variance has been removed by the correction for attenuation, $r^2 \times 100$ is the percentage of relationship that can be designated general strength ability common to the two hands, and $k^2 \times 100$ is the amount of individual abilities that are specific to the one hand or the other hand.

Since the corresponding muscles of each hand are used, and the motor task is the same for each hand, it is logical to designate the specificity component as "bilateral neuromotor specificity." The data in Table 3 show that the amount of specificity is somewhat greater than the amount of generality of hand strength ability.[2]

Summary and Conclusions

A hypothesis, derived from the Davis neural overflow theory, predicted a facilitation of hand strength when the contralateral hand was simultaneously contracted. In an experiment designed to test the hypothesis, the expected facilitation failed to occur; on the contrary, there was a negative effect.

The statistical evidence justifies the conclusion that the single maximal contraction of the dominant hand is probably more forceful than is the case when the contraction is simultaneous in both hands. There is interference

[2] E. W. Seymour has found correlations of .67 and .72 for bilateral grip strength in high school boys (see his "Follow-up Study on Simplification of the Strength and Physical Fitness Indexes" in the May 1960 RESEARCH QUARTERLY). While these are somewhat higher than found in the present study of college men, the bilateral specificity is still in the region of 50 percent or more.

TABLE 3.—CORRELATIONS BETWEEN INDIVIDUAL DIFFERENCES IN HAND GRIP STRENGTH

	Single Trials		Average of Two Trials	
	Raw	Corrected	Raw	Corrected
Reliability[a]				
Dominant	.820	.901	.931	-----
Nondominant	.768	.869	.861	-----
Bilateral correlations[a]	.542[b]	.683[c]	.601[d]	.671[c]
Generality (r^2 x 100)		47%		45%
Specificity (k^2 x 100)		53%		55%

[a] All correlations are above .361, the value required for significance at the 5 percent level.
[b] Average of the two correlations .531 and .553.
[c] Corrected for attenuation.
[d] Computed from the average score of the two single trials.

rather than facilitation. However, the nondominant hand strength is unaffected by the simultaneous contraction of the other hand.

Individual differences in hand grip strength exhibit a rather large amount of bilateral neuromotor specificity under the conditions of the present experiment. After removing statistically the influence of unreliability, the amount of grip strength ability that is general, i.e., common to the two hands, tends to be somewhat less than the amount that is specific to the right or left hand as the case might be. It must be concluded that individual differences in hand strength involve abilities that are specific to the individual neuromotor pattern of the right or left hand. These specific neuromotor abilities are as extensive as the general hand strength ability that characterizes the individual.

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Effects of Mental Practice and Physical Practice upon Muscular Endurance

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Abstract

The purposes of this study were twofold: first, to test the hypothesis that muscular endurance can be increased through a mental rehearsal of a particular item of endurance; second, to determine whether the increase, if any, would be as great as or greater than that achieved solely through physical practice of the same item. Results indicated that muscular endurance of the abdominal and thigh flexor muscles is increased significantly over a 20-day period by a daily five-minute mental practice of sit-ups. It was also found, however, that the increase was significantly smaller than that achieved by a daily five-minute practice of sit-ups. It was concluded that where physical practice is at all possible, this method is recommended over mental practice to facilitate an increase in muscular endurance.

WITHIN THE FIELD of physical education and athletics in general, there has always been concern for the large amount of practice which is required for improvement in an activity. It has been accepted generally that improvement comes only from hours of physical practice and an unspecified amount of concentration. Although widely accepted as a fact, this procedure has never really been experimentally substantiated. Similarly, practice solely by a mental rehearsal or reminiscence has never been tested in the practical or everyday situation, as distinct from the controlled laboratory experiment. However, a few experiments in mental practice in the acquisition of motor skills have been conducted in the laboratory and are outlined here.

Review of Literature

Acquisition of Motor Skills. In the first published study of the acquisition of motor skills through mental practice, Vandell, Davis, and Clugston (12) ran three separate experiments using dart throwing as the motor skill practiced in two of these and a standard basketball free throw in the third. Each group of 12 boys was equated into three subgroups. Group I practiced the particular motor skill on the first and twentieth days, Group II on each of 20 days, and Group III on the first and twentieth days with either 15 or 30 minutes of mental practice from the second day to the nineteenth day inclusive. On the twentieth or final day all three groups repeated the test given on the first day. The results showed that high school boys shooting basketball free throws improved 2 percent under condition one, 41 percent under condition two, and 43 percent under condition three. Junior high school boys throwing darts showed a 2 percent decrease in performance under condition one, a 7 percent improvement under condition two, and a 4 percent improvement under condition three. College freshmen made no improvement under condition one, 23 percent improvement under condition two, and 22 percent improvement under condition three.

A study in 1948 by Twining (11) generally followed the procedure established by Vandell, Davis, and Clugston. In Twining's experiment, however, a ring toss was sub-

stituted for the dart throw and basketball free throw, one experiment only was run for 21 days, and mental practice was carried on for 15 minutes. This consisted of a mental rehearsal of the ring toss. Results from this experiment showed 4.3 percent improvement by the group having no practice, 137.3 percent by the group practicing physically, and 36.2 percent by the group practicing mentally.

Apparently unaware of Twining's experiment, Steel (9) conducted a similar experiment in 1952 in England. However, Steel used a baseball throw for accuracy in place of Twining's ring toss, and the mental group practiced for only ten minutes on each of nine days. The results showed that the group receiving no practice improved 7.6 percent, the group practicing physically improved 15.3 percent, and the group practicing mentally improved 11.9 percent.

Karpovich and Hale (6) have reported that Malarecki has shown that running time in a 60-meter race improved when a subject thought about performing warmups before a race rather than performing them physically. However, information on this study is incomplete and therefore cannot be considered conclusive.

In all of these studies but the latter, which is not fully reported, the reliability of the test item could be questioned, as could the method of controlling variables in the groups practicing mentally. For instance, an equal amount of time is not spent by the groups practicing mentally and physically, nor is there any method of determining whether the mental group was reminiscing or concentrating on the particular item tested.

Problem Defined

Rather than selecting the motor skills area previously studied, the author chose a new aspect of muscular activity, muscular endurance. There have been no experimental studies made on the effect of mental practice versus physical practice in this area.

It has not been decided conclusively whether the test item selected, sit-ups, is one of muscular strength or muscular endurance. Authorities argue from both standpoints but generally have little scientific or experimental evidence to support their views. A conclusion, however, was reached for the purposes of this study on the basis of the following comments and studies.

In 1946 Wedemeyer (14) conducted a study to determine the relationship between sit-ups and such factors as strength, endurance, and weight. He concluded that there was no significant relationship between sit-ups and sit-up strength and weight, and that after sit-up strength reached a certain level, further improvement in the number of sit-ups was accompanied by no significant increase in strength. The endurance factor appeared to improve more than did strength.

DeLorme (2) differentiates between muscular strength and muscular endurance on a different basis. After experimentation with exercises other than sit-ups, he stated that "low repetition, high resistance exercises produce power (strength), and high repetition low resistance exercises produce endurance." He also claims that power-building exercises and endurance-building exercises are two entirely different types, each one producing its own results, and each being wholly incapable of producing the results obtained by the other.

Capen (1) used both aspects of DeLorme's information in a comparative study of three methods of sit-up training. He considered that practicing sit-ups either by two minutes, total number, or total number with a weight behind the head in preparation for a test involving the total number of sit-ups would give nearly equal results.

DeWitt (3) conducted a study to determine the degree to which different tests of the sit-up type correlate with criteria of abdominal muscle strength and endurance. He found that sit-ups without having the ankles held, sit-ups with a slow lowering of the

trunk until the head touched the floor, and sit-ups with ankles held for a two-minute test were all only slightly positively correlated with the criterion of endurance. This criterion, however, was a test in which the abdominal muscles were in a continuous state of contraction, while the tests involved alternate stages of contraction and relaxation.

Moreover, it has been suggested by McCloy (8) that, as far as endurance tests such as sit-ups are concerned, they are strongly influenced by strength only at the lower levels and that they are primarily measures of muscular endurance.

On the basis of the preceding discussion and experimental results, endurance was defined as the ability to continue repeated muscular activity.

Methods and Procedure

In order to lessen the influence of strength upon muscular endurance and to classify sit-ups as an item of muscular endurance, only individuals were selected who fell within one negative standard deviation of the mean for students of this university (7).

The "total number of sit-ups" was selected for test purposes because the result of this test is a true indication of the extent to which the individual can continue repeated contraction and combat fatigue, which is one criterion of a muscular endurance test (10). In addition it eliminates the factor of speed as a possible confusing variable.

The five-minute sit-up test was selected for practice periods by the group practicing physically. It was necessary to use this test to establish a practice time limit for the physical practice group in order that time spent practicing physically would be comparable to time spent practicing mentally.

Four activity classes of the required physical education program at the University of British Columbia were selected at random for the purpose of choosing students to participate in the experiment. All students within these classes were given a "total number of sit-ups" test. All students were retested one week later. The coefficient of correlation for the test-retest was .81.

Students were then selected by the matching by pairs technique to engage in the experiment (4). This system of selection was used until three groups of 12 were obtained. Assigning of individuals to groups was done on a basis of cataloged random selection.

The groups were classified according to the condition under which they practiced the tests. The conditions were:

Condition I—12 boys on the first and twenty-second day;

Condition II—12 boys on the first and twenty-second day with five minutes each day from the second through twenty-first day physically rehearsing the first day's activities; and

Condition III—12 boys on the first and twenty-second day with five minutes on each day from the second through twenty-first day mentally rehearsing the first day's activities.

After completing the retest, individuals of Condition I were told that they were not to return until the twenty-second day when they were to repeat the test. They were asked not to think about, discuss, watch, or practice the item in the meantime.

Boys under Condition II and III practiced at the same time of day, between 12:30 and 1:00 p.m. Condition II students practiced in a lecture room

five days a week Monday through Friday for four weeks. They were told to perform as many sit-ups as possible within a five-minute period, record their own results, and leave them with the observer.

Individuals practicing under Condition III practiced in the same lecture room five days a week Monday through Friday for four weeks also. They were told to rehearse mentally the first day's activity and to concentrate on nothing other than the sit-up item. They were to spend five minutes mentally practicing the physical skill. New techniques could be devised and attempted mentally. If and when reading material on the topic was available, it could be consulted. At the four and one-half minute mark, they were given 30 seconds in which to make a short statement on a sheet provided for this purpose. In this statement the subject stated either how he was performing the test item or how many sit-ups were being done mentally, or were being attempted, etc. The subjects also answered one question daily, on some aspect of sit-up technique or procedure.

Because it was almost impossible to determine what the individual was actually thinking, controls were not as highly objective as desired. Observation, replies to daily questions, and brief statements on the line of thinking were the measures by which the subject's thinking was evaluated.

At the end of 21 days trials ceased. On the twenty-second day individuals from all three groups were given the original test. Improvement was measured by the t ratio and the level of confidence necessary for significance was established as .05 in all measurements.

Results

Improvement was measured within groups, and a comparison of this improvement was made between groups. Gain within groups was measured by the difference in mean scores between practice day one and practice day 22.

Table 1 shows the increase in endurance. It is evident that Condition I (no practice) resulted in little increase. The subjects improved 8.7 percent, which is not statistically significant since the t ratio is only 1.24. The ratio is typical of chance effects only. Condition II (physical practice) resulted in 322.8 percent gain or an average increase of 112.52 sit-ups, which is statistically significant at the .01 level of confidence. Condition III (mental practice) resulted in 29.1 percent improvement or an average increase of 10.14 sit-ups, which is statistically significant at the .05 level of confidence.

TABLE 1.—IMPROVEMENT IN ENDURANCE DUE TO PRACTICE

Condition	Practice Periods	Mean 1st Day Score	SD 1st Day Score	Mean 22nd Day Score	SD 22nd Day Score	Percent Improvement	t
I	2	34.86	6.22	37.88	10.84	8.7	1.25
II	22	34.86	6.22	147.38	89.52	322.8	3.61[a]
III	22	34.86	6.22	45.00	13.62	29.1	2.92[b]

[a] Significant at .01 level of confidence.
[b] Significant at .05 level of confidence.

Comparison of improvement between groups was made by measuring the difference between mean scores of day 22, as shown in Table 2. The results showed that the difference between Condition I (no practice) and Condition II (physical practice) was highly significant with a t ratio favoring Condition II. The difference between Condition II and Condition III (mental practice) was also significant in favor of Condition II with a t ratio of 3.14. The difference between Condition I and III, however, was not statistically significant since the t ratio was only 1.39. The wide variation in improvement between groups is graphically portrayed in Figure I.

TABLE 2.—COMPARISON BETWEEN GROUPS OF FINAL MEAN SCORES

Groups	Mean 22nd Day Score	SD 22nd Day Score	t
Physical Practice			
vs.	147.38	89.52	3.44
Control	37.88	10.54	
Mental Practice			
vs.	45.00	13.62	1.39
Control	37.88	10.84	
Physical Practice			
vs.	147.38	89.52	3.14
Mental Practice	45.00	13.62	

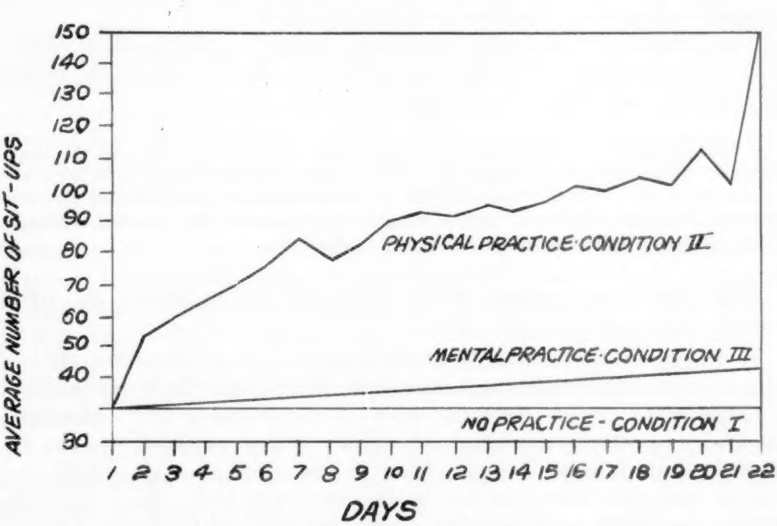

FIGURE I. Learning Curve for No Practice, Physical Practice, and Mental Practice. From day 2 to day 21 inclusive practice was for five minutes. On day 1 and day 22 sit-ups were performed on an unlimited time basis for subjects under all three conditions.

Discussion

It would appear that mental practice and physical practice both facilitate an increase in muscular endurance. The relative value between mental and physical practice in muscular endurance, however, is not easily defined as to the amount of time which should be spent on each method of practice. From the results as shown in Tables 1 and 2, a combination of the two elements of practice appears desirable. Emphasis, however, should be on the physical.

It is perhaps to be expected that muscular endurance would be increased by mental practice to an extent somewhere between that achieved through actual physical repetition and that attained through no practice. As Steel states (13) "the effects of reminiscence, the integrating activity of the brain's structure, would suggest that an increase would be the most probable result to expect (even) where no practice occurs." Apparently Steel surmises that concentration assists the integrative action of the central nervous system, besides sending impulses more frequently to the musculature. According to Wakim (13), however, in the generally unexercised muscle the onset of fatigue will occur more rapidly than in the exercised muscle because of a combination of exhaustion of acetylcholine of the myoneural junction and an inability of the circulatory system to supply oxygen and to rapidly remove waste products, especially lactic acid, from the exercised muscles. Conversely, the increase in endurance of the physical practice subjects is probably due to the increased ability of their bodily systems to exchange nutrients and waste materials efficiently, as well as the increased ability of the nervous mechanism to transmit impulses to the muscle fibers.

The physiological processes (which may account for the significant difference in improvement of the physical group over the control and the mental groups) are best summed up by Hemingway (5) who says:

> It seems possible . . . that many of the signs and symptoms of fatigue in the neuromuscular system might be explained in terms of anoxia and the failure to strike a balance between the processes responsible for the conduction and transmission of the nerve impulses and the supply of oxygen necessary to maintain the chemical processes concerned in the maintenance of the nervous mechanisms.

Other factors were present, however, which tended to enhance the difference.

1. During the experiment the physical practice group (Condition II) was able to observe the gradual improvement in their scores. Each day provided a challenge to improve over the score of the preceding day. Moreover, knowledge of other group members' scores provided an added stimulus for improvement. Interest became keener as the experiment progressed and various techniques were used, e.g., holding the breath while raising the trunk, holding the breath while lowering, closing the eyes and developing a kinesthetic sense of rhythm, racing through the test item or performing it slowly, methodically, or rhythmically.

2. Opposed to this practical experimentation and knowledge of progress was the lack of similar stimulation for the mental practice group. Individuals of this group, of course, did not plot their progress in the same manner as the physical practice group. Not until the end of the experiment did they see the results of their practice.

3. Except for the final 30 seconds, the mental practice period was spent mentally rehearsing the test item of sit-ups. According to questionnaire replies, various techniques were attempted by everyone. The mental group was at a disadvantage in the testing of these techniques. Although the form of the item was generally uniform for all subjects, e.g., hands interlaced behind neck, partner holding ankles 12 inches apart, etc., certain variations in pace, breathing, and method of count could not be adopted. Subjects of the physical practice group had an opportunity to experiment with variations to arrive at a style suited to them well in advance of the final test. On the contrary, the mental practice group had to test their technique on the final day, which gave them little opportunity to perfect a technique. This would tend to favor improvement in the scores of subjects under Condition II (Physical Practice).

Summary, Conclusions, Recommendations

Subjects receiving no practice showed no significant improvement in muscular endurance. The group receiving physical practice improved 322 perent or increased on an average of 112.52 sit-ups and the group receiving mental practice improved 29 percent or 10.14 sit-ups. In both of these groups the improvement was statistically significant at the .01 and .05 levels of confidence respectively. There were statistically significant differences in mean final scores between physical practice and no practice, and between physical practice and mental practice. In both instances the significant difference was in favor of physical practice. There was no statistically significant difference between mental practice and no practice.

It is concluded that both physical and mental practice, under the conditions of the experiment, are effective in increasing muscular endurance. The degree of increase with respect to mental practice, however, is not sufficiently large enough to advocate its use exclusive of physical practice where physical practice is possible. Physical practice is a much more effective means of increasing muscular endurance than mental practice.

It is recommended that further studies in this area deal with the following problems.

1. In practice which utilizes a combination of mental and physical practice, what should be the ratio between time spent on physical practice and time spent on mental practice?

2. Can performance be improved as much through physical practice as through a combination of physical and mental practice?

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Specificity or Generality of Speed of Systematically Related Movements[1]

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Abstract

The maximal speeds of discrete arm and leg movements similar to the actions of throwing a baseball or kicking a football were tested in 80 college men. Repetitive (cyclic) movements involving both arms or both legs were also measured. Individual differences were highly reliable, ranging from r = .92 to .99. Intercorrelations between discrete and repetitive movements were very low, ranging from r = .03 to .16. While the correlations were somewhat higher between arm speed and leg speed, namely .39, the amount of task specificity under the most favorable circumstances was about 85 percent, compared with 15 percent common variance that could be ascribed to a general "speed of limb movement" factor. The results suggest the need to revise current concepts of the nature of motor abilities, since individual differences in making a fast movement are evidently quite specific to the particular motor task, rather than existing as a speed component that could be measured in a motor ability test.

THE CONCEPT OF motor generality is traditional; it is often referred to in the physical education literature. Nash (19) lists the development of general motor coordination as one of the important objectives of physical education. McCloy (16) has developed tests labeled general motor capacity and general motor ability. Brace (1) speaks of fundamental motor ability which all individuals use in learning and performing physical activities. Larsen (14) states that general motor ability (or general athletic ability) is the ability of the individual in the elements assumed to underlie motor performance, such as muscular strength, muscular power, muscular endurance, coordination, agility, and balance.

Review of Literature

An investigation by H. G. Seashore (23) showed that there was little relationship between fine and gross motor abilities, so that generalizations based on the former might not be valid for the latter. However, more than half of his 55 intercorrelations between the different gross motor skills were r = .2 or less, and 65 percent were statistically nonsignificant. The results of his factor analysis show that for the gross motor skills, only 45 percent of the individual differences are accounted for by one or the other of his four factors, the remainder being unique to each of the specific skills tested and thus unrelated to general motor ability or group factors describing motor ability.

In discussing fine and gross motor skills, R. H. Seashore (24) hints at the possibility that large muscle coordinations may be general instead of specific. He states that "it is

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[1] From the Research Laboratory of the Department of Physical Education of the University of California, Berkeley. The writer is indebted to Franklin Henry for advice and criticism.

useful to distinguish between gross motor skills used in athletics and the finer coordinations involved in other manual activities because many of the experimental findings differ in an important way. For example, Cozens showed that there is a moderate correlation between gross motor skills of athletic types. . . ."

The study by Cozens in 1929 (2), referred to by Seashore, was probably the first to report correlations between gross motor abilities. A group of college men were tested in a large number of athletic skills, in order to develop the Cozens test of General Athletic Ability. The test is still in use. Although Seashore refers to the Cozens intercorrelations as moderate in size, the majority of them ranged between .2 and .3. The reliability coefficients were high. As will be explained later, correlations this low must be interpreted as offering evidence for task specificity rather than general performance ability.

In 1934, Ragsdale and Breckenfeld (20) tested junior high school boys in a number of football, baseball, basketball, and track skills. As a result of finding low intercorrelations, they contended that it is probably erroneous to speak of general motor ability; certain common or group factors, however, such as strength, speed and accuracy, may exist.

One of the most extensive studies of the interrelationships of gross motor skills was conducted by Jones (13) in 1935. He factor analyzed the performance of over 2000 college men with respect to what he termed "fundamental motor skills." These were a running high jump, a standing bar vault, a rope climb, a sprint run, and a baseball throw for accuracy. The resulting correlations were all low, indicating the lack of any important relationships between the different abilities. Jones therefore concluded that the results showed specificity of motor ability.

For the purpose of analyzing the primary elements which make up speed, Rarick in 1937 (21) carried out a factor analysis based on the relationships among several gross motor abilities in 51 college men. Various static strength measures, vertical jumping ability, a sprint run, and a shot put were intercorrelated. The majority of the intercorrelations were low, although a relatively high correlation ($r = .63$) was found between two particular events, the vertical jump and the sprint run, as had been observed by others (17).

Recently, there have been several studies related to the issue of specificity versus generality. In commenting on the high degree of task-specificity that they had found in studies of exercise metabolism, Henry and Trafton in 1951 presented evidence that this was probably caused by the specificity of neuromotor skills (6).

Cumbee (3, 4) in 1954 and 1957 attempted to develop a simple definition of motor coordination by means of a factor analysis of 22 motor ability test items. The wide variety of motor coordination tasks included a basketball throw and soccer kick for distance, rod balancing items, ball catching and striking, and a jump-reach test. Although Cumbee identified a number of factors in both studies, inspection of the factor loadings reveals that they were relatively small, and the amount of specificity (not computed by Cumbee) is quite large (11). There were in general only one or two items in each factor that had substantial loadings. The number of factors was relatively large as compared with the number of independent test items in the original correlation matrix. These data can be considered to be consistent with the concept of motor specificity rather than generality, particularly when one notes the low intertask correlations.

Testing two samples of college women in a large number of motor tasks, Scott (22) in 1955 found very low intertask correlations. She concluded, therefore, that there is "considerable specificity of function." Moreover, she was led by her data to the conclusion that "kinesthesis is made up of many elements or forms of response. Needless to say, kinesthesis plays an important role in neuromotor action.

A recent (1958) study by Fleishman (5) investigated relationships between individual differences in positioning movements and static reaction tasks required in piloting aircraft. The positioning tasks involved moving the various limbs to a specific point in space in which terminal accuracy of the response was measured, while the static reaction tests required holding a limb steady while in a fixed position. All the more than 200

intercorrelations were low, with over 90 percent ranging between ± .2. Fleischman concluded that ability in these kinds of coordinations is highly task specific.

In two recent papers (1956-58), Henry discussed problems in the area of large muscle motor learning and performance abilities (7, 8), and emphasized that additional basic research is badly needed in this area. He held that physical educators must face up to the issue of generality versus specificity of motor ability; our researchers and curriculum planners have evaded this question; they have continued to assume that gross motor abilities are general, or made up of group factors such as strength, speed and coordination, without considering all of the facts that have been available.

Problem Investigated

The theory of specific motor abilities, as viewed by Henry (7), contends that some individuals may possess considerable degrees of aptitude in many specific abilities; they are the potential all-round athletes. At the other extreme some individuals may possess only a very few specific abilities in significant amounts; they are the motor morons. Task specificity, according to this theory, implies that it is largely a matter of chance whether an individual who has relatively high (or low) ability in one motor task will have high or low ability in another motor task, unless the two tasks are so similar as to be practically identical. It does not deny the presence of reliable individual differences in motor abilities, but does state that such individual differences tend to show little or no intercorrelation as between different tasks. Neuromotor or task specificity implies that individual abilities in performing a specified motor task with a particular group of muscles tend to have only a low correlation with individual abilities in performing a different task using largely the same group of muscles (12).

It follows from his concepts that a valid test of general motor ability as such is impossible. A test battery can only sample specific abilities, and therefore can only be effective in predicting a criterion that involves the specific abilities that are sampled. This of course states the extreme position. To the extent that there is some intercorrelation between abilities that are only relatively specific, a somewhat broader prediction would be possible. It therefore becomes important to find out just how specific are the individual differences, not only with respect to general motor ability, but also within one of the so-called factors that are said to constitute motor ability, namely strength, endurance, agility, coordination, and speed. If, for example, speed exists as a component of motor ability, there should be a substantial correlation between individual differences in measured speed of neuromotor performance, especially if the performances are done by the same limbs and involve the same general type of movement in two tasks.

The present study is an investigation of individual differences in neuromotor or task specificity as explained above, correlating the maximum speed of crank turning (using two arms) with the speed of isolated single arm movements having considerable components of similarity with the cranking movement. The second aspect of the study is the correlation of the maximum speed of cranking by the legs with isolated leg movements of a similar nature.

The third aspect is a study of what might be called segmental specificity, involving the correlation of maximum speed of arm movement or arm cranking with maximum speed of leg movement or leg cranking. Details of how these studies have been accomplished will be given below.

Methodology

Repetitive Arm Movement. A bicycle frame was mounted on a vertical wooden support fastened to the laboratory wall, with the pedal crank projecting forward. Slots in the support made it possible to adjust the crank to shoulder height. The rubber treads and their holders were removed from the pedals, so that the subject could turn the crank with his hands. He wore light cotton gloves to prevent irritation and blisters. His task was to turn the crank as rapidly as possible for 30 sec., using both arms equally. He was given one practice start and 5 sec. of turning before the first trial. A second trial was given approximately an hour later, the other tests of the experiment being performed in the interim. A microswitch attached to the crank operated an electric revolution counter. The writer had used this apparatus in a previous experiment (15); the single-trial reliability was .82.

Single Arm Movement. A stand with a horizontal arm approximately 6 ft. high supported a string which suspended a tennis ball at the height of the shoulder joint. The upper end of the string was fastened to a small plastic pull-out strip, which was held to the arm of the stand by a spring clip attached to the stopping microswitch. When the ball was touched, it fell down, causing the microswitch to operate. A second horizontal arm held the starting microswitch 28 in. in front of the ball, at a height of 6 ft. For testing the right arm, the subject stood with his right shoulder facing the ball; this placed his shoulder under the starting microswitch, but approximately 8 in. inward to the left. At the start of the movement, his forearm was flexed at the elbow, the upper arm being horizontal and directly sideward from the shoulder.

The index knuckle of the subject's hand was placed on the starting microswitch. His task was to swing the hand forward and downward in an arc, so as to strike the ball which served as a target. The movement was initiated by the flash of a signal light placed near the ball; he was instructed to make the movement as fast as possible throughout. An electric chronoscope having a known variable error of $\pm$ 3.1 millisec. (9) was automatically started and stopped by the microswitches. This amount of instrumental error is negligible in an experiment of this type (10). The time scores were converted into speed in ft./sec. The first five trials with each arm were discarded; the average of the following 20 trials constituted the subject's score.

Repetitive Leg Movement. The subject rode a stationary bicycle with the chain removed so that friction was minimal. The seat was adjusted to the height of the subject, so that the knee was slightly flexed at the bottom of the pedal stroke. Toe clips and foot straps were used. A microswitch operated an electric revolution counter. The instructions, length of test, and number

of trials, etc., were the same as in the repetitive arm movement test. It should be noted that pedaling an unloaded friction-free bicycle at maximum speed, using foot straps, requires a different type of leg action than that which is used in ordinary bicycling. The main impulse comes from the quadriceps muscles at the top of the pedal stroke.

Subjects and Order of Testing. All of the 80 subjects were volunteers, 70 percent from R.O.T.C. classes and 30 percent from physical education classes. They were freshmen and sophomores, ranging in age from 19 to 22 years. All testing of each subject was done in a single one-hour period. Every subject followed the same pattern of testing. The order was: repetitive arm movement, repetitive leg movement, single right arm and single left arm movements, single right leg and single left leg movements, retest of repetitive arm movement, retest repetitive leg movement.

Procedure. Standard instructions were given to each subject at appropriate places during the testing period. Before starting, it was emphasized that all movements were to be made at maximum speed. The arm crank test was explained and demonstrated. The crank was adjusted to shoulder level. The starting procedure was then explained and a 5-sec. practice start was given. Just before starting it was again stressed that the subject was to turn the crank at full speed until told to stop. After the command, "ready, go!," the subject turned the crank for 30 sec., while the experimenter recorded the revolutions for each 5-sec. period.

While the subject rested for 5 min., the leg bicycle test was explained and demonstrated. The seat was then placed at the correct height according to the length of the subject's legs, and his feet were strapped onto the pedals to prevent slipping. The remainder of the procedure was the same as that followed in the arm crank, including instructions, trial run, test length, and recording procedure.

The subject then rested another 5 min. while the single arm movement was explained and demonstrated. Instructions were given to hit the suspended ball as fast as possible and not worry about missing it. Twenty-five trials were then given for the right arm. After a 5-min. relaxation period, the subject was given 25 trials with the left arm. Next, the leg movement was explained and demonstrated. It was stressed that the subject must move as fast as possible. Twenty-five trials were then given for the right leg and 25 for the left, with a rest of five min. in between. He was then retested on both the arm crank and leg crank tests.

Results

Reliability of Individual Differences. The Spearman-Brown corrected reliability coefficients, along with the means and standard deviations for the six movements, are presented in Table 1. The uncorrected coefficients range from .86 to .96; after correction the range is .92 to .99. These are relatively high reliabilities.

Correlations between Movements. The correlations between individual differences in performance by the different limbs, and in the two types of motor tasks, are given in Table 2. It can be seen that speed of movement ability, as measured in a single arm or leg, is unrelated to speed of movement ability as measured by repetitive movement employing two arms or two legs. The correlations are very close to zero, ranging from .03 to .13. The multiple correlation between the repetitive movement of the arms and the combination of the two arms tested singly is .06, for the legs is .16. None of these differs significantly from zero.

There is a statistically significant correlation (r = .39) between speed for repetitive movements done by the arms and done by the legs. Also when the speeds of the two single arms are averaged, and the speeds of the two single legs are averaged, the correlation between arm speed and leg speed is r = 37, which is almost exactly the same as the r = .39 found for the repetitive movements.

Discussion

Motor Specificity Theory. The results of the study clearly indicate that there is high specificity (k^2) as compared to generality (r^2) in all of the coordination abilities investigated. Since individual differences in the various tasks are very reliable, correlations between the various tasks remain low

TABLE 1.—DESCRIPTIVE STATISTICS AND RELIABILITY COEFFICIENTS

Movement	M	σ	r
Arm Crank[a]	3.41 revs./sec.	.184 rev./sec.	.920
Leg Crank[b]	3.02 revs./sec.	.214 rev./sec.	.958
Right Arm	18.82 ft./sec.	2.31 ft./sec.	.999
Left Arm	18.09 ft./sec.	2.28 ft./sec.	.964
Right Leg	14.49 ft./sec.	1.00 ft./sec.	.980
Left Leg	13.97 ft./sec.	0.92 ft./sec.	.981

[a] The arm crank diameter was 14 in.
[b] The leg crank diameter was 11 in.

TABLE 2.—CORRELATIONS BETWEEN MOVEMENTS AND BETWEEN LIMBS

Movements	Raw r	Corrected for attenuation	Generality[a] r^2	Specificity[a] k^2
Arm Crank vs. Right Arm	.064	.068	.004	.996
Arm Crank vs. Left Arm	.031	.033	.001	.999
Arm Crank vs. Two Arms	.062	......	.004	.996
Leg Crank vs .Right Leg	.025	.026	.001	.999
Leg Crank vs. Left Leg	.131	.135	.018	.982
Leg Crank vs. Two Legs	.158	......	.025	.975
Arm Crank vs. Leg Crank	.391[b]	.417[b]	.174	.826
Two Arms vs. Two Legs	.370[b]	.394[b]	.155	.845

[a] See Mendryk (18) for an explanation of these coefficients.
[b] Correlations above .217 are significant at the 5 percent level.

even when fully corrected for attenuation, and the individual differences are almost completely accounted for by the k^2 or specificity factor as shown in Table 2.

Of greatest importance in terms of choosing between the theories of specificity and generality of motor abilities are the extremely low correlations found between the performance of movements which largely involve the same muscle groups and similar joint actions. The two types of arm movements chosen for study (single versus repetitive) are very similar in these respects. Considered as a test of the specificity theory, the conditions were overly harsh. Had substantial correlations been found, the specificity theory would not have been upset. On the contrary, all that would have resulted would have been the establishment of a limit to the degree of specificity that exists in motor abilities. This argument applies also to the study of leg movements. In view of the facts obtained, the specificity theory is upheld; the results testify to an extreme degree of specificity, as shown by the high values of k^2.

Conclusions

Eighty college men were tested for their maximum speed in turning a two-handled arm crank (repetitive movement). The speeds of the single arms were also measured, using the two arms individually as they performed movements involving muscle and joint action comparable to that used in turning the crank.

The performance of the same subjects was also measured in comparable movements made by the legs. The experiment was designed to test the hypothesis that individual differences in neuromotor ability were specific even for movements and tasks of considerable similarity.

The correlations between the single arm and repetitive two-arm movements, and between the comparable leg movements, were very low even after full correction for attenuation. While there were significant correlations between total upper limb and total lower limb speed abilities, these revealed approximately 85 percent specificity as compared with only 15 percent generality of individual differences in speed ability. It is therefore concluded that the neuromotor specificity of speed of movement ability of the arms and legs in college men is extremely high.

These findings of extreme neuromotor specificity of motor abilities are consistent with the degree of task specificity that has been computed from data reported by other investigators.

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Effect of Warm-Up Exercise upon Muscular Performance Using Hypnosis to Control the Psychological Variable

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Abstract

Observations were made on 15 male subjects riding a bicycle ergometer 100 revolutions against time after two conditions, warm-up by means of over-all bodily activity for a period of ten minutes and no warm-up. The subjects were tested four times, two times following each condition. The subjects were in a deep hypnotic state prior to all testing, and when tested they had no conscious awareness of whether they had warmed up. Performances after the two conditions were about the same with the rate of pedaling slightly slower following warm-up. The differences in mean performances were not statistically significant. There was no evidence of muscle strain or injury resulting from performance without warm-up.

Review of Literature

It has been reasonably well established that muscular performance in terms of rate or force of movement can be improved in the early stages by preceding such movements with identical movements of moderate intensity and duration. The well-known *treppe* effect found in the classical experiment with the gastrocnemius muscle of the frog illustrates this phenomenon. Studies conducted on humans have also indicated this, particularly when the studies have involved such relatively simple movements as tapping a key, following a pursuit roto-meter, extending a joint, throwing a ball, or jumping vertically from a crouched position. Wells (26), Batty (2), Robinson and Heron (19), Henry (6), Renshaw (18), Michael, Skubic, and Rochelle (13), Swegan, Yankosky, and Williams (24), Pacheco (16), Merlino (12), and Rochelle, Skubic, and Michael (20) all have presented supporting evidence. Skubic and Hodgkins (23) and Thompson (25) have also presented supporting evidence, but not conclusive in nature.

When one considers warm-up movements which are relatively unrelated to a criterion performance composed of simple muscular activity of short duration, the findings are not entirely consistent, but in general they indicate that such preliminary activity improves performance. Michael, Skubic, and Rochelle (13) and Pacheco (15, 16) found, respectively, that throwing a baseball for distance and jumping vertically were somewhat increased by unrelated warm-up activity. Paseltiner (17) found that speed of arm movement, apparently, was increased or slowed depending upon the intensity of the preliminary exercise. Burke (4) reported that strength improved, but that coordination was not affected. Skubic and Hodgkins (23) failed to find any appreciable improvement in throwing a ball for accuracy or distance following general, unrelated warm-up.

Turning to studies employing as a criterion muscular activity of some complexity and duration, e.g., riding a bicycle ergometer or running a race, it is found that the value of warm-up activities, even of the directly related type, has not been well established. Asmussen and Bøje (1), Schmid (21), and Thompson (25) reported studies which dis-

tinctly favored related warm-up. Karpovich and Hale (8) and Skubic and Hodgkins (23) obtained results which favored warm-up, but not at a statistically significant level. These investigators, in evaluating their findings, discounted the value of warm-up. Hipple (7) and De Vries (5), using running and swimming performances, respectively, as their criteria reported findings which neither favored warm-up nor indicated that it limited performance. Karpovich and Pestrecov (9) reported that preliminary activity in the form of pedaling an ergometer actually hindered endurance pedaling.

When studies have dealt with the effect on athletic type performances of warm-up exercises of the kind frequently used in athletics, that is, where warm-up has consisted of a generalized, total body warm-up with some of the movements related to the athletic performance and some quite unrelated, the findings have been quite inconsistent. Simonson, Teslenka, and Gorkin (22) and Blank (3), using sprint running as the criterion, and Muido (14), using 50-meter to 400-meter sprint swims as criteria, each concluded that general bodily warm-up exercises were quite effective. De Vries (5) using as a criterion 100-yard swimming performance with two groups employing different strokes found that one group improved significantly after warming up while the other did not. Karpovich and Hale (8) using a 440-yard run, Skubic and Hodgkins (23) employing one tenth of a mile bicycle ergometer ride, Burke (4) employing as criteria rate of running in place for ten seconds and endurance running in place, Thompson (25) using swimming speed for 30 yards and swimming endurance as indicated by the distance swum in five minutes, and Lotter (10) observing the effect of general warm-up on endurance as indicated by turning a crank for four minutes, all presented data and/or concluded from their studies that generalized exercise warm-up had little or no positive effect upon performance. Mathews and Snyder (11), studying the 440-yard performance of high school boys after a typically moderate warm-up consisting of jogging, stretching, and sprinting found that performance was better after no warm-up, although the differences in mean times of a little over a half second were not statistically significant.

Purposes

The conflicting evidence reported with respect to the effect of preliminary warm-up exercises upon athletic types of performances stimulated this investigation. The purpose of the study was to observe the effect of warm-up by means of preliminary general activity upon muscular performance as indicated by the rate at which a bicycle ergometer could be pedalled for 100 revolutions. Two experimental conditions were utilized: a ten-minute period of rest with a minimum of physical activity, and a ten-minute period of exercise consisting of warm-up activity in the form of over-all bodily exercises.

Procedures

Four major factors appear to be responsible for the conflicting findings reported in previous studies: (a) the difficulty encountered in controlling environmental conditions when using as the criterion some type of competitive athletic performance; (b) the limited number of subjects studied, to the point that statistically significant findings, in some instances, were virtually impossible; (c) inadequate psychological control of the subjects in terms of the popular belief that warm-up is beneficial; and (d) the limited number of repeated observations made upon each subject.

Control of the first three of these factors was believed attained in this study by: (a) conducting the study in a laboratory environment; (b) using a sufficient number of subjects for the application of small sample statistics;

and (c) controlling the subjects' awareness of the experimental conditions by utilizing hypnosis and keeping the subjects in ignorance of the nature and purpose of the research. The number of performance tests for each subject was limited to four, two following each of the two experimental conditions. This limited number of test rides was dictated by the requirements of the experiment. Volunteer subjects in good physical condition, willing to undergo the stress of severe physical effort and susceptible to deep trance hypnosis, were difficult to obtain. Also, despite the fact that bicycle pedaling involves movements with which most individuals are familiar, a performance plateau is difficult to attain, requiring a prohibitive number of trials (1). Consequently, to ensure the continued interest and cooperation of the few subjects available the number of test trials was limited to four.

Fifteen young adult males served as subjects. They ranged in age from 21 to 32 years with a median age of 24.2 years. The subjects appeared to be in normal health and in good physical condition. All were college athletes and/or physical education majors.

The subjects were tested on four different days. Only one test ride was taken by a subject on any given day. The test consisted of pedaling a friction type bicycle ergometer 100 revolutions as rapidly as possible. Performance time was recorded to the nearest tenth of a second using a manually operated stop watch. The bicycle ergometer was set at a constant load of 26 lbs., giving a work output for 100 revolutions of 9,399 ft.-lbs. The distance the feet moved was roughly equivalent to that of a 100-meter dash, and the time consumed approached that necessary for a 400-meter run.

The testing procedure was as follows. The subject, upon reporting to the laboratory, was seated in a darkened, quiet room and immediately placed in a hypnotic trance. The criteria for minimum depth of trance were the ability to experience vivid visual and auditory hallucinations, and complete posthypnotic amnesia concerning what took place during the trance. The subject, after from five to ten minutes in the quiet room, moved to the main laboratory, a distance of some ten yards. He immediately changed outer clothing, putting on a sweat suit and gym shoes. He then underwent one of the two experimental conditions, namely, ten minutes of sitting quietly in a chair near the ergometer or ten minutes of moderate exercise. The warm-up exercise routine consisted of two minutes jogging in a 30-foot diameter circle, one minute of side straddle hopping, one minute running in place, one minute jogging again in a circle, one minute of 30-foot wind sprints, a half minute of alternate toe touching from the standing position, and a half minute of running in place. The subjects underwent the experimental conditions while in deep hypnotic trance. The warm-up routine was sufficiently vigorous to always induce visible perspiration. As a result of careful training the hypnotized subjects demonstrated excellent skill in performing the exercise movements.

Following the ten-minute experimental period the subject sat quietly for two minutes. When the preceding ten-minute period consisted of quiet sitting, water was sprinkled on the subject's forehead to simulate perspiration. This

was done in an effort to eliminate on the part of the subject, when awakened, any possible curiosity as to why on one occasion his face was moist and on another relatively dry. The subject was aroused after the two-minute period of sitting, removed his sweat clothing, and mounted the bicycle ergometer. The test ride started within two to three minutes after the subject was aroused.

The same costume was worn by each subject for all tests. This consisted of gym shoes, a T shirt, and shorts. Conditions of testing were standardized in terms of pedal resistance, height of the ergometer seat relative to the length of the subject's legs, method of timing the ride, and directions given in administering the test. Room temperature during the course of the tests varied on a day-to-day basis between 72° and 82° F. with a mean temperature of 74.9°. A comparison of mean room temperature on days when the test rides followed warm-up with days when the ride followed no warm-up showed a difference of only 0.5°.

An attempt was made to balance out the effect of practice, or conditioning, by alternating the sequence of testing from one subject to the next. For example, if one subject was tested in the sequence of no warm-up, warm-up, no warm-up, warm-up, the next was tested in the sequence warm-up, no warm-up, warm-up, no warm-up. This procedure of alternating the sequence of testing was not entirely successful since four of the 19 subjects who started the study dropped out, leaving nine who followed the last sequence of cold[1], warm-up, cold, warm-up, and six following the sequence of warm-up, cold, warm-up, cold.

It was not possible to control the daily activities of the subjects during the period of testing. Each subject, however, was requested to observe a brief list of precautions concerning his activities for a 24-hour period preceding a test. These precautions had to do with the number of hours sleep the night before testing, exercise, eating, and similar items. After each test the subject filled out a questionnaire indicating his activities during the preceding 24-hour period. The subjects were under no duress to follow the conditions specified, and it was believed that their questionnaires reflected reasonably accurately their activities prior to testing. An analysis of these questionnaires revealed no condition which would seem to bias the results in favor of one experimental condition as opposed to the other.

An effort was made to test a subject at approximately the same time each day. This was accomplished with a reasonable degree of success. Eight of the subjects took all four tests within a two-hour time range, while the other seven deviated from the two-hour range in only one test, respectively. The tests were run between 9:00 a.m. and 5:00 p.m.

The number of days elapsing between two consecutive tests for a given subject ranged from zero to 53. The median was five days. Eleven of the 15 subjects did not have any elapsed period between two consecutive tests exceeding eight days.

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[1]To avoid possible confusion, the term "cold" is used to denote the "no warm-up" condition.

Psychological control of the subjects appeared to be excellent. None gave any evidence of being curious concerning what happened to them while in the hypnotic trance. The subjects were not told the nature of the study other than it had to do with hypnosis and all-out performance on a bicycle ergometer.

Results

Throughout the four test rides the performance of the subjects steadily improved as indicated by a decrease in mean riding times. This decrease is illustrated in the graph for mean riding times of the tests, Figure I, and by Table 2. This factor of improvement tended to favor performance following warm-up for those who were tested in the test sequence of cold, warm-up, cold, warm-up and to favor performance with no warm-up for those who were tested in the test sequence of warm-up, cold, warm-up, cold. Because four of the subjects voluntarily dropped from the study after testing was under way, nine subjects were tested in the sequence favoring warm-up and six were tested in the sequence favoring no warm-up. Despite this, when a comparison was made between the mean performances following warm-up and no warm-

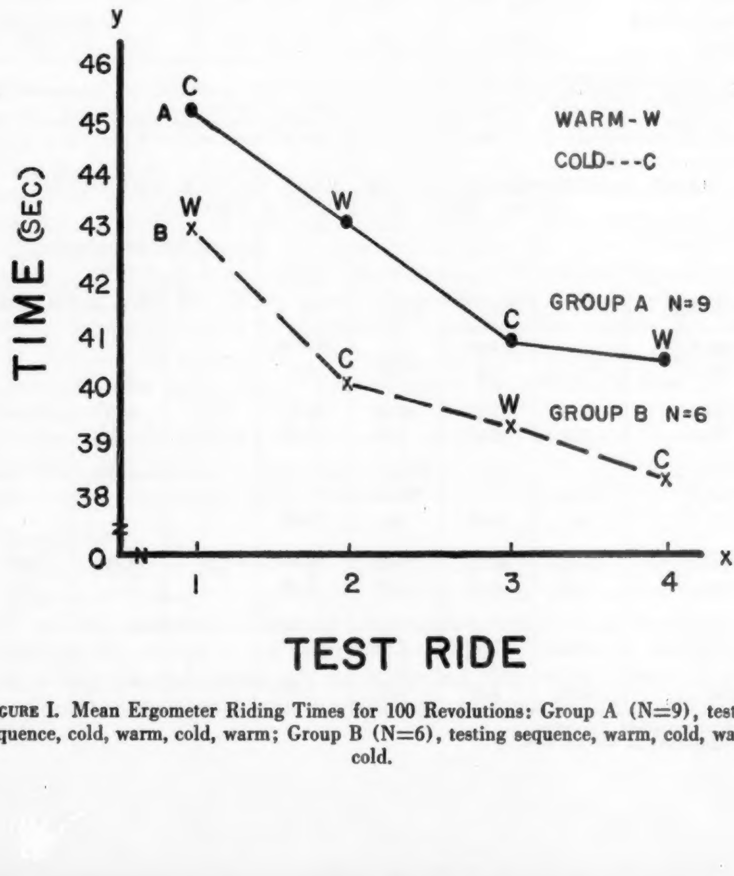

FIGURE I. Mean Ergometer Riding Times for 100 Revolutions: Group A (N=9), testing sequence, cold, warm, cold, warm; Group B (N=6), testing sequence, warm, cold, warm, cold.

up for the entire group of 15 subjects, the fastest mean times occurred following no warm-up. The differences in times, however, were quite small and not statistically significant (Table 1).

Because of the marked improvement in riding times with repeated testing and because of the imbalance which existed in terms of the number of subjects tested with respect to the two sequences, the data were further analyzed on the basis of two groups formed by separating the subjects in terms of test sequence. Group A (N = 9) was composed of those subjects tested in the cold, warm-up, cold, warm-up sequence and Group B (N = 6) consisted

TABLE 1.—COMPARISON OF BICYCLE ERGOMETER PERFORMANCES WITH AND WITHOUT PRELIMINARY WARM-UP
(N = 15)

Trials	Warm-up		Cold[b]		
	$\overline{X}$	$\bar{\sigma}$[a]	$\overline{X}$	$\bar{\sigma}$	t ratio
First Trial[c]	43.09 sec.	4.11	43.23 sec.	4.05	0.13
Second Trial	40.11 sec.	3.26	39.89 sec.	3.43	0.61
Average of two trials	41.59 sec.	3.37	41.56 sec.	3.48	0.05

[a] σ = Standard deviation computed using N-1.
[b] To avoid possible confusion between the "Warm-up" and "No Warm-up" conditions, the term "Cold" has been used to designate the "No Warm-up" condition.
[c] The first "Warm-up" or "Cold" trial for a given subject was either Test 1 or Test 2, depending on sequence of testing. The second trial was either Test 3 or Test 4.

TABLE 2.—COMPARISONS OF THE MEAN BICYCLE ERGOMETER RIDING TIMES OF GROUPS A AND B

Groups	Test 1	Test 2	Test 3	Test 4	Test Differences t ratios		
					$\overline{X}_1 - \overline{X}_2$	$\overline{X}_2 - \overline{X}_3$	$\overline{X}_3 - \overline{X}_4$
Group A (N = 9)	Cold	Warm-up	Cold	Warm-up			
$\overline{X}$ (Sec.)	45.28	43.13	40.92	40.62	2.96[b]	3.24[b]	0.64
S[a] (Sec.)	2.72	2.84	3.35	2.96	——	——	——
Group B (N = 6)	Warm-up	Cold	Warm-up	Cold			
$\overline{X}$ (Sec.)	43.03	40.15	39.33	38.35	1.51	0.95	2.08
S (Sec.)	5.23	3.38	3.26	2.58	——	——	——
$\overline{X}_A - \overline{X}_B$	2.25	2.98	1.59	2.27			
t ratio	0.89	1.65	0.85	1.46			

[a] S = Standard Deviation.
[b] Significant at the .05 level.

of those subjects who were tested in the warm-up, cold, warm-up, cold sequence. It seemed reasonable to assume that these two groups came from the same population and that their performances were affected equally by the repeated test rides. Consequently, it was hypothesized that any difference between the two groups in performance on any given test or any difference in improvement in performance from one test to the next, aside from that expected by chance, could be attributed to the influence of the experimental variable. Presumably, if warm-up affected performance either favorably or unfavorably, the mean performance on Test 1 by Group B should be significantly different from the performance of Group A, since the former performed Test 1 following warm-up and the latter performed it without warm-up. Likewise, a comparison based on the decrease in time for the two groups from Test 1 to Test 2 should accentuate the influence of warm-up, since in Group A the sequence was from cold to warm-up and in Group B from warm-up to cold. A comparison of the two groups on these bases indicated once again that performance following warm-up was slightly poorer than that following no warm-up, but the differences were not statistically significant (Tables 2 and 3).

Discussion

The findings cause one to wonder why warm-up did not cause improvement in performance. Perhaps warm-up is primarily of psychological value and the control by hypnosis eliminated this factor. The matter of fatigue also is a factor to be considered. Perhaps in this study the warm-up routine was too vigorous, although it seems unlikely that well-conditioned subjects would be unduly fatigued by a ten-minute period of relatively moderate activity followed by a five-minute rest. Negative results sometimes result from inadequate measuring techniques. This seems not to be the case in this instance, as the reliability of the data in terms of the test-retest coefficients of correlation were reasonably good. The coefficients obtained when Test 1 was correlated with Test 2, Test 2 with Test 3, and Test 3 with Test 4 were .66, .82, and .93 respectively ($N = 15$). It is interesting to note that the findings of this study support the findings of Karpovich and Hale (8) and Mathews (11).

After each test ride, the subjects were questioned as to how they felt, particularly with regard to their legs. Subjects' responses gave no indication that muscle soreness or injury resulted from performing without warm-up.

Conclusions

The findings of this investigation in no way support the contention that warm up by over-all, general bodily activity such as is commonly used prior to athletic performance improves subsequent muscular performance of a type similar to that found in sprint running. Furthermore, although not rigorously pursued, there was no indication that rather intense muscular performance at room temperature without warm-up results in soreness or injury.

TABLE 3.—COMPARISON OF THE MEAN DECREASES IN RIDING TIMES FROM TEST TO TEST FOR GROUPS A AND B

Group A			Group B			A − B	
Tests	$\overline{X}_{Diff.}$	$\tilde{\sigma}_{Diff.}$[a]	Tests	$\overline{X}_{Diff.}$	$\tilde{\sigma}_{Diff.}$	$\overline{X}_D - \overline{X}_D$ A B	t ratio
$T_1 - T_2$ (Cold) (Warm)	(Sec.) 2.15	2.17	$T_1 - T_2$ (Warm) (Cold)	(Sec.) 2.88	4.68	0.74	0.36
$T_2 - T_3$ (Warm) (Cold)	2.21	2.05	$T_2 - T_3$ (Cold) (Warm)	0.82	2.11	1.39	1.26
$T_3 - T_4$ (Cold) (Warm)	0.30	1.42	$T_3 - T_4$ (Warm) (Cold)	0.98	1.16	0.68	1.01
Av. T_1 & T_3 (Cold) minus Av. T_2 & T_4 (Warm)	1.22	1.41	Av. T_1 & T_3 (Warm) minus Av. T_2 & T_4 (Cold)	1.93	2.17	0.71	0.71

[a] $\tilde{\sigma}$ = Standard Deviation computed using N-1.

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(Submitted 2/23/60)

Rate and Pattern of Recuperation from the Effects of Ethyl Alcohol on Man as Measured by Selected Gross Motor Skills[1]

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Abstract

The purpose of this investigation was to study the rate and pattern of recuperation from the effects of ethyl alcohol on man as measured by selected gross motor tests. One level of alcohol (2 oz.) and one testing time, with graduated time intervals between consumption of alcohol and the performance test, were used in the experiment. There is a clear pattern of recovery from the effects of alcohol on man as measured by the selected gross motor tests.

THIS STUDY WAS an attempt to furnish information relative to unanswered questions growing out of a recent research project, "Effects of Ethyl Alcohol on the Performance of Selected Gross Motor Tests" (1). The original study contained a battery of six physical performance tests (grip strength, starting and running, softball throw for accuracy, vertical jump, bicycle ergometer, and push-ups) which were administered three days each week: (a) the day before consuming alcohol, (b) at the peak of the blood concentration, which was 30 minutes following the last of three drinks (drinking covered a 45-minute period), and (c) the day following the drinking. No alcohol, two ounces, and three ounces were used in a cross-over design so that each subject served as his own control. Residual effects of the alcohol were not found to be significant in 24 hours, whereas drinking alcohol (2 and 3 oz.) on the day of performance did significantly affect performance on the tests. Four of the six skills (speed and reaction, bicycle ergometer, softball throw, and vertical jump) decreased approximately twofold in proficiency from two ounces to three ounces of alcohol.

Since performance was definitely affected shortly after consuming ethyl alcohol but not 24 hours later, it posed the question, "What is the rate or pattern of recovery from varied amounts of alcohol on man as measured by gross motor tests?" The present investigation was designed in an attempt to answer this question.

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[1]This project was supported by a grant from the Utah State Board on Alcoholism and completed under Utah State University Research.

Procedure[2]

Subjects for the experiment were male students in good physical condition attending Utah State University.

Experimental Design. The study was a completely randomized design (1) involving only one amount of alcohol (2 oz.) and one testing time, with graduated time intervals between consumption of alcohol and the performance test (Table 1). Alcohol was administered eight, four, two, one, and one-half hours prior to testing, using different subjects randomly assigned in each group.

The battery of gross motor tests was given two different days prior to the alcohol test day for control purposes on each subject. A control group of nine men was also tested for two different days to ascertain the amount of conditioning and learning on the tests; it was tested on the third day as well, with no alcohol.

Drinking. Consumption of the beverage was carefully controlled. Only small groups of five or six subjects were utilized at any one time, and subjects from all groups in the experimental design were included. The subjects knew that they were getting alcohol, but not the amount. However, they were told that it was not enough to cause them any concern. A nose clip was used during the drinking, and drinks were mixed with Tom Collins mix, lemon juice, grape juice, and ice. A total of two ten-ounce glasses of liquid was consumed. The alcohol was equally distributed in the two drinks.

TABLE 1.—EXPERIMENTAL DESIGN

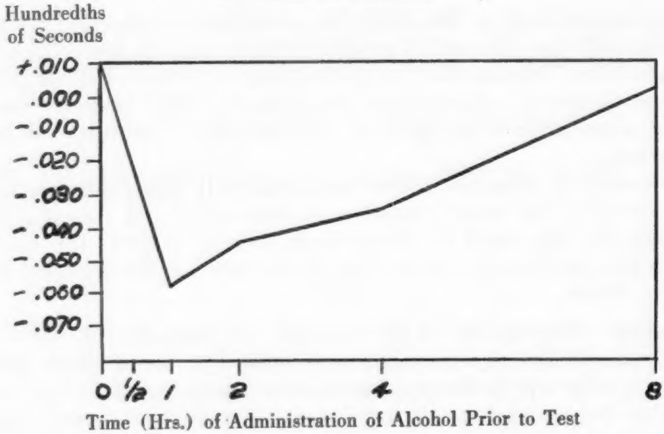
Group (nine men each)	Time of Administering Alcohol Prior to Performance Test		
1	8 hours	or	9:00 a.m.
2	4 hours	or	1:00 p.m.
3	2 hours	or	3:00 p.m.
4	1 hour	or	4:00 p.m.
5	½ hour	or	4:30 p.m.
	Test Time		5:00 p.m.

Since the alcohol concentration in the blood is dependent upon the size of a person's liver, which is in turn related to body size, various amounts were given to each person, depending on his weight. The exact amount of two ounces was given if the subject weighed 160 pounds, with proportionately more or less, depending on how much more or less the subject varied from the base weight. If, for example, a subject weighed 210 pounds, which is 50 pounds over the base of 160, he received one-half ounce more than the prescribed level.

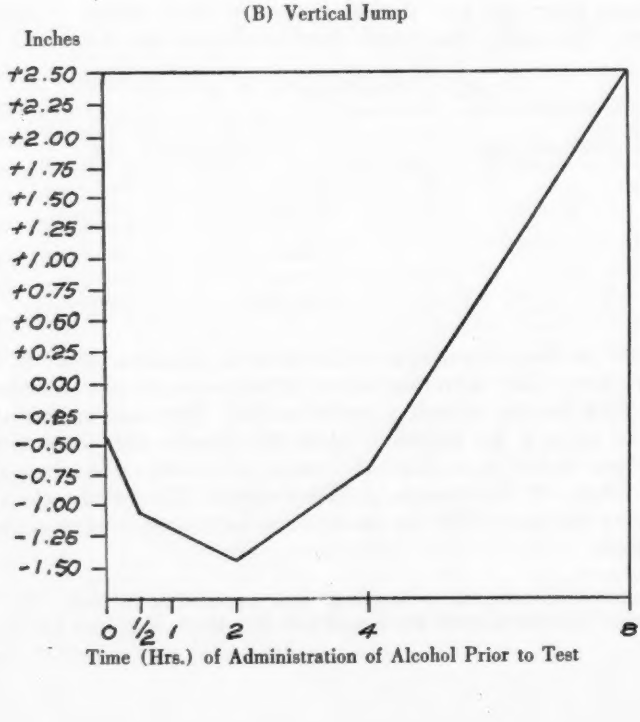
[2]The statistical designing and computations were completed in the Utah State University Statistical Laboratory under the direction of Rex Hurst, Kwo Hwa Lu, and Don Sisson.

FIGURE I. Pattern of recovery from two ounces of alcohol. Individual mean changes from the control day tests as compared with tests on the drinking day.

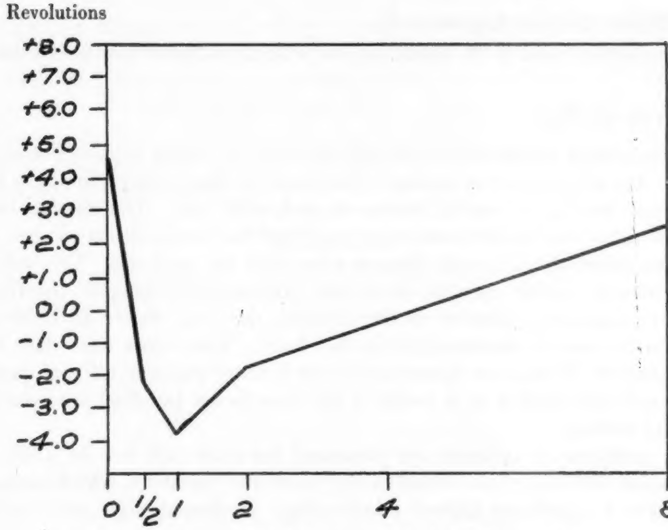
(A) Speed and Reaction



(B) Vertical Jump



(C) Bicycle Ergometer



Time (Hrs.) of Administration of Alcohol Prior to Test

Blood concentration of alcohol is dependent upon many conditions which include the contents of the stomach. Therefore, beverages were ingested on an empty stomach so that this factor could be controlled.

Tests

The coefficient of variation for three of the six tests of the original study indicated high precision, so they were selected for use in the present experiment. The physical performance tests were selected to test such basic components as strength and endurance, speed and reaction time, and power (vertical). The tests were given in the sequence listed so that the effects from one test to another would be uniform.

Test One—Starting and Running

An upright starting position was used with each subject running ten yards. The electric timing device was started by clapping two copper-covered boards together. As the sheets of copper came together, the clock started and continued until the runner broke the electric circuit by striking a gate switch, waist high, across the finish line. Time was recorded to the nearest 1/100 sec. Each subject's daily score included the average of the timed trials.

Test Two—Vertical Jump

The subject reached as far as possible with heels kept on the floor and made a chalk mark on the wall. He next executed three jumps from a crouched position, making a finger imprint each time on the wall board. The distance from the top of the reach

mark to the top of each jump mark was measured. The average of three jumps was used as the daily score.

Test Three—Bicycle Ergometer

Maximum revolution in 60 seconds against a 10-lb. resistance was used as the daily score.

Analysis of Data

Each subject was tested on the skill tests for two days prior to being tested on the day of consuming alcohol. The mean of these two preliminary testing days was used as a control score on each skill test. The change between control score and alcohol test score was listed for each subject of each group and the accumulated group changes were used for analysis. The individual mean change which resulted from the accumulated changes (control day tests as compared with tests on the drinking day) are shown in Table 2 and seem to be more understandable in this form. These data were then treated with analysis of variance procedure to see if there was a significant quadratic or curved relationship as a result of the time factor involved between drinking and testing.

The analyses of variance are presented for each skill test in Table 3. A significant difference was found in the quadratic variation, which means that there was a significant curved relationship. It showed high and low points

TABLE 2.—INDIVIDUAL MEAN CHANGES FROM THE CONTROL DAY TESTS AS COMPARED WITH TESTS ON THE DRINKING DAY

Tests	Group 1 9 a.m. or 8 hrs.	Group 2 1 p.m. or 4 hrs.	Group 3 3 p.m. or 2 hrs.	Group 4 4 p.m. or 1 hr.	Group 5 4:30 p.m. or ½ hr.	Group 6 0 or Control
Starting and Running (hundredth of a second)	—.004	—.034	—.044	—.060	—.021	+.008
Vertical Jump (inches)	+2.33	—0.59	—1.07	—1.33	—1.09	—0.47
Bicycle Ergometer (revolutions)	+2.55	—0.22	—1.78	—3.44	—1.33	+7.33

TABLE 3.—ANALYSIS OF VARIANCE OF THE STARTING AND RUNNING, VERTICAL JUMP, AND BICYCLE ERGOMETER TESTS

Source	Degrees of Freedom	Starting and Running Mean Square	Vertical Jump Mean Square	Bicycle Ergometer Mean Square
Linear	1	.00941	1.217	45.873
Quadratic	1	$.025725^{(.01)}$	$6.674^{(.05)}$	$553.716^{(.025)}$
Remainder	3	.000702	.185	26.779
Within	48	.003002	1.273	95.491

significantly different, and there was no straight line or linear effect. The pattern or curved relationship is shown more clearly in Figure I.

The pattern of recuperation shows complete recovery between four and eight hours after drinking on the vertical jump, whereas recovery is not quite complete after eight hours on the bicycle ergometer and starting and running tests. However, the pattern seems to be clear and relatively similar on all tests. It should be noted that the lowest point, or the time when two ounces of alcohol had the most effect, was one hour after drinking rather than the expected 30 minutes following the last drink.

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(Submitted 11/18/59)

Relationship of Maturation Age to Incidence of Injury in Tackle Football[1]

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Abstract

X-ray films of the right hand and wrist of 62 boys, age 13 to 16 years, engaged in tackle football (junior high school) were assessed for maturation (skeletal) age. Of this group, 31 were injured and a like number were not injured during a regular season of play. In the injured group, 21 (68%) were advanced, their skeletal age being more than their chronological age, and 10 (32%) were retarded, their skeletal age being less than their chronological age. The average skeletal age of the injured group was 15 years 5 months, and the average chronological age was 14 years 9 months, a difference of 8 months. This difference was found to be significant at the 5 percent level of probability. In the noninjured group, 23 (74%) were advanced, and 8 (26%) were retarded. The average skeletal age of the noninjured group was 15 years 3 months and the average chronological age was 14 years 8½ months. This difference of 6½ months was found to be significant at the 2 percent level of probability. The mean difference in skeletal age between the two groups was not statistically significant. Within the limits of this study, no relationship was found between skeletal age and incidence of injury.

MANY INDIVIDUALS TODAY voice strong disapproval of tackle football at the junior high school level on the basis that injuries to boys in this age group might be due to incomplete skeletal maturation. Others, however, take issue with this viewpoint and express the opinion that tackle football, for numerous reasons should be initiated at this level. The evidence available, however, is not conclusive enough to substantiate either viewpoint.

Review of Literature

Cowell (4) summarizes the problem of physiological maturity and the desirability of playing football as follows:

> The two most important facts seem to be the relation of actual physical strength to physiological age and the extent to which the cartilages of the long bones of the physiologically immature can stand the power of impact possible in rugged competitive games like football without possible permanent damage.

Lowman (15) is of the opinion that the stresses and strains of competitive athletics upon the joint structures of growing and immature children may enhance the possibilities of future difficulties which nature is unable to surmount. Since the skeletal structures are in a state of rapid growth preceding and during adolescence, the joint structures and the epiphyseal growth cartilages are especially vulnerable at this time.

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[1]This study was supported in part by University of California Faculty Research Grant No. 120.

Krogman (13) describes the tremendous growth surge of the early teens as the "vulnerable age." He adds that during this period excessive activity-demand games, such as football, may be harmful to the organism.

Jones (10) found that at the onset of puberty the development of certain types of coordination, balance, and agility might be temporarily retarded. Frequently this retardation occurs at the time when the boy is engaged in strenuous competitive athletics.

Dimock (5), Jones (11), and Espenschade (6) reported research on the subject of motor performances of children during the puberty period of rapid growth. They discovered lags or recessions in motor performance during this period. These studies and others reveal a well-established relationship between motor performance and physiological maturity. Studies of the relationship of skeletal maturity and body size consistently show a close relationship between these two factors (2, 3, 7, 12, 13, 16).

Fait (8) studied the effects of athletic competition on certain anthropometric measurements of junior high school boys. He concluded that competitive athletics are not detrimental to the physical health when precautions are taken regarding adequate physical examinations and guarding against the condition of staleness.

A Joint Committee (1), representing the Department of Elementary School Principals, NEA; the National Council of State Consultants in Elementary Education; the Society of State Directors of Health, Physical Education, and Recreation; and the AAHPER, solicited the opinions of pediatricians, cardiologists, physiologists, orthopedists, and general practitioners in regard to the effects of athletic competition on boys from 12 to 15 years of age. Football was the only listed activity consistently labeled by the majority as an activity to be prohibited at this level.

Fait (8) solicited the opinions of 100 orthopedists in regard to the effects of competitive athletics on junior high school boys. Of the 70 who responded, 60 expressed the opinion that epiphyseal injuries were less prevalent than other bone injuries in the junior high school group. This is contrary to the opinions expressed by physicians in the Joint Committee study in which 47% believed that competitive athletics created a special hazard in connection with fractures of the epiphyseal area of long bones.

Fait (9) in an analytical study of the available literature pertaining to the effects of strenuous activity upon the immature child reveals some definite conclusions. He was able to show that the preponderance of evidence indicates that possible danger to a sound heart is very remote, if possible at all, because the reserve of the other body structures will fail before the reserves of the normal heart are exhausted by the physical demands. His comments regarding accidents indicate that the greatest percentage of boys injured in athletics are found among the postpubescent group. He is of the opinion that until such time as all the factors which may produce injuries are known, the actual relationship of age to the number and nature of injuries cannot be determined accurately.

Many physicians and lay people are agreed that football is too dangerous for boys at the junior high level and would disapprove of existing tackle football programs. Still, one cannot help but question whether these so called objectors are in a position to make a valid evaluation.

Procedure

Subjects. The subjects for this study were 62 boys, approximately ten each from six junior high schools in the Los Angeles, California, area. The ages of the subjects ranged from 13 to 16 years. Thirty-one of the boys were injured during the football season. A similar number were not injured. The two groups were matched on age, height, weight, and physical ability.

Maturation (Skeletal) Age. Maturation (skeletal) age was determined by an X-ray of the right hand and wrist. These X-ray films were assessed for skeletal age by a medical doctor using Todd's Atlas as a standard for levels of maturation. A record was kept of injuries occurring during the actual

playing time of practice session and scheduled games. Injuries were defined in this study as skeletal injuries involving fractures, dislocations, and sprains.

Results

Skeletal Maturation—Chronological Age. Of the 31 boys in the injured group, 10 (32%) were retarded, their skeletal age being less than their chronological age. Of this same group, 21 (68%) were advanced, their skeletal age being more than their chronological age. The average chronological age of the injured group was 14 years 9 months (range 13:7-16:0), and the average skeletal age was 15 years 5 months (range 12:0-18:0), a difference of 8 months advanced skeletal age over chronological age. This difference was found to be significant at the 5 percent level of probability (see Table 1).

In the noninjured group, 23 (74%) were placed in the advanced maturation category and 8 (26%) were classified as retarded. The average chronological age of this group was 14 years 8½ months (range 13:3 to 16:4) as compared to a skeletal age of 15 years 3 months (range 12:0 to 17:6). This difference of 6½ months, advanced skeletal age, was found to be significant at the 2 percent level of probability (see Table 2).

According to Krogman (14) a difference of ± 11 months in chronological and skeletal age is within a normal acceptable range of variation. In accordance with this, of the injured group, 14 (45%) were advanced and 6 (19%) were retarded; 11 (36%) were within Krogman's accepted range of variation. In the noninjured group, 13 (42%) were advanced and 5 (16%) were retarded; 13 were within the accepted range of variation.

A statistical comparison of the means of the skeletal age of the two groups resulted in a t of 0.54 which falls short of significance (see Table 3). Although no significant difference was shown between the injured and noninjured in skeletal age, it seems logical to hypothesize that the boys whose skeletal age was greater than their chronological age probably participated to a greater extent. Accordingly, if this were reduced to hours of participation, perhaps it would require less exposure for injuries to appear among the boys who are not as mature. The hypothesis would not be tenable, since there is little difference in both practice and game time between the advanced and retarded subjects in the injured group. In addition, the proportionate exposure time was greater for the retarded individuals of the noninjured than the retarded of the injured. No significant difference was found bewteen the retarded of the injured and noninjured in skeletal age.

Discussion

From the material presented, it is apparent that no relationship exists between skeletal maturation and incidence of injuries sustained during a season of tackle football. The average skeletal age for both groups was greater than the chronological age. This indicates that the majority of boys were biologically advanced regarding maturation level.

TABLE 1.—COMPARISON OF MEANS BETWEEN CHRONOLOGICAL AND SKELETAL AGES OF INJURED GROUP

Age	Mean (Months)	Difference Between Means			
		Diff.	S.E. Diff.	t	P
Skeletal	185.0				
Chronological	177.0	8.0	3.42	2.339	.05

TABLE 2.—COMPARISON OF MEANS BETWEEN CHRONOLOGICAL AND SKELETAL AGES OF NONINJURED GROUP

Age	Mean (Months)	Difference Between Means			
		Diff.	S.E. Diff.	t	P
Skeletal	183.0				
Chronological	176.5	6.50	2.49	2.604	.02

TABLE 3.—COMPARISON OF MEANS BETWEEN SKELETAL AGE OF THE INJURED AND NONINJURED GROUPS

Group	Mean (Months)	Difference Between Means			
		Diff.	S.E. Diff.	t	P
Injured	185				
Noninjured	183	2.0	4.84	0.413	

One important factor must be considered, however. This is the number of pulled muscles occurring as a result of incomplete ossification. This aspect was not pursued in this study, although it might be a significant reason for opposing tackle football at this age level.

The range of skeletal maturation was approximately 12:0 to 18:0 years for botth injured and noninjured groups. This appears somewhat large, and it might be more desirable to determine levels of competition by means of skeletal rather than chronological age.

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(Submitted 5/4/60)

Effect of Differential Motive-Incentive Conditions on Physical Performance

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Abstract

Four matched subgroups were given a grip strength test under one of four motive-incentive conditions. There were no differences in performance between the groups that received threat of electric shock, knowledge of results, constant exhortation, or were simply asked to do as well as possible. Further, there were no differences in performance between groups at various levels of strength.

THE FACT THAT certain motive-incentive conditions have a marked influence on learning and performance of verbal material has been well established (2, 5). While attempts to manipulate the level of motivation in performers of physical skills through special incentives have been common, research as to the effects of those incentives has been limited. Further, those studies that do exist are contradictory to the extent that some show improvement under motive-incentive conditions and others show no effect.

Review of Literature

Ulrich and Burke (7) tested a group of 18 subjects on a bicycle ergometer under two varieties of motivational stress. All subjects received three trials. On the first trial, subjects were told to pedal for one minute, doing as well as possible. Scores were reported at 30 and 45 seconds. On the second and third trials subjects were again asked to do as well as possible, equaling or improving on the first trial. They were instructed that a bell would ring periodically if their performance improved, but if their performance was below the previous standard a buzzer would ring. Unknown to subjects, it was determined prior to testing whether the buzzer or bell would ring during the trials, regardless of performance. All groups heard the bell on one trial and the buzzer on the other. Results indicated no difference in total work output between the two motivating conditions, although both of these conditions were significantly better than the initial trial.

Fleishman (1), after giving 400 subjects preliminary training on a rudder control test (maneuvering a type of Link trainer in response to visual signals), divided the subjects into two groups, giving one a variety of motive-incentive instructions and the other no instructions or encouragement after the preliminary test. The performance of the motivated group was significantly better than that of the control group. When the groups were divided into best and poorest performers on the basis of test scores, there was no significant difference between the performance of the poorest half of the control group and the poorest half of the experimental group. The best performers in the motivation group, however, had significantly better test scores than the best performers in the control group.

Noble (6), using 400 subjects, gave a preliminary practice period on a two-handed coordination test (tracking). At varying periods of practice, experimental groups were informed of their average score and told that they must improve if they were to pass. The author concluded that the incentive-motive conditions did not affect performance.

Johnson (3) had 59 junior high school boys, with instructions to do as well as possible, pedal a bicycle ergometer against a fixed resistance of five pounds. The subjects were given eight 30-second trials, with a 30-second rest between each trial. Each subject had two tests, one with continuous verbal encouragement, the other with no encouragement. There was no significant difference between performance under the two conditions.

Problem Investigated

A review of the literature reveals little as to the effect of various types of incentives on physical performance. Therefore the purpose of this experiment was to determine the relative effect of four different motive-incentive conditions on a simple task that required neither endurance nor skill. In addition the effect of the motive-incentive conditions at varying levels of performance was investigated. The specific task studied was grip strength as measured by a hand dynamometer.

Methodology

Eighty male university students participated in the experiment. All were volunteers, obtained from voluntary physical education classes. No particular systematic method of selection was used. All subjects, using only the right hand, were given a preliminary test of grip strength, consisting of three trials with a hand dynamometer. They were told that this was a test to determine their grip strength. Special emphasis was placed on the fact that maximum effort was essential. Results were not shown to the performers.

A second test was administered seven days later and the subjects were told that this test would determine, among other things, the reliability of grip strength. The same general procedures used in the first test were followed with one exception. On the second test each subject received one of four different motive-incentive conditions. Group one, the control group, was given the same instructions as on the first test, being told to squeeze as hard as possible and to make a maximum effort on each trial. Group two, the verbal group, was told to try to improve on their first score (they had no knowledge of initial scores), and as they performed were verbally encouraged to impove with such statements as "harder, harder, much harder." Group three, the knowledge of results group, knew their initial scores, were allowed to watch the dynamometer scoring dial, and were told to make every effort to improve on the initial score. Group four, the shock group, had an electrode attached to the left wrist, were informed of initial scores, and were told that failure to improve on each trial would result in receipt of a severe electric shock.

Apparatus

To provide the electric shock a transformer increased the 120-volt supply to 350 volts and insulated the power line and its ground for safety reasons. Sufficient resistance was placed in the circuit to limit the electrode current to 4.4 milliamps per square centimeter of contact area. The electrodes were 9 by 11 millimeters in size, separated by 7½ millimeters distance from edge

to edge, mounted in a small plastic strip and held on the wrist by an elastic strap.[1]

A Lafayette hand dynamometer was used to measure grip strength. Although the dial of the dynamometer was marked in kilograms, it was necessary to multiply obtained scores by 0.88 and add 15.5 to obtain true kilograms. In this study, however, all scores reported were taken directly from the dial without conversion.

Results and Discussion

In designing the experiment the author reasoned that differences in performance between subjects on the initial test might be attributed to varying levels of motivation, with higher levels of motivation resulting in superior scores. If this hypothesis were true, added incentive would be expected to produce greater gains in the lower scoring subjects.

Therefore, this experiment was designed to provide a test to determine whether or not the four types of incentives had the same relative effect at all levels of strength, and at the same time provide a test of the null hypothesis that there were no differences between the four types of motive-incentive conditions.

Subjects were arranged on the basis of their initial strength test, from strongest to weakest and were divided into four levels of strength, with the strongest 20 assigned to the superior group, the next 20 to the good group, the third 20 to the fair group, and the weakest 20 to the poor group. Within each of the four levels the subjects were randomly assigned to one of the four motive-incentive groups, 20 per group. Thus all groups were matched with reference to the initial strength score.

The results of a simple variance analysis on initial strength measures, shown in Table 1, indicate no differences between the four groups ($F = 0.02$) prior to the application of the motive-incentive conditions. The reliability of the test-retest on the initial strength measures was .88.

Mean scores for the four motive-incentive conditions are shown in Table 2. While three of the four groups appear to be equal, scores for the shock group are considerably higher. Results of the analysis of variance, shown in Table 3, however, indicate that the differences between groups are not significant ($F = 2.34$, with $F = 2.75$ required for significance at the 5% level).

When strength scores are broken into groups by levels (Table 2) the mean scores for the superior group are quite similar. At the lower three levels both the shock group and the verbal group appear to have higher mean scores than the control group. These observed differences are not significant, however, with $F = 0.46$ for the interaction of groups by levels. (For significance at the 5% level, F had to equal 2.02.)

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[1] See description of apparatus used by F. M. Henry in the article "Increase in Speed of Movement by Motivation and by Transfer of Motivated Improvement" which appeared in the May 1951 RESEARCH QUARTERLY.

TABLE 1.—ANALYSIS OF VARIANCE FOR INITIAL STRENGTH SCORES

Source of Variance	SS	DF	MS	F
Between	42.28	3	14.09	0.02
Within	89,337.96	96	930.60	
Total	89,380.24	99		

TABLE 2.—MEAN SCORES FOR THE FOUR MOTIVE-INCENTIVE GROUPS[a]
(Groups X Levels)

	Knowledge	Verbal	Control	Shock
Superior	184.0	179.4	188.8	191.4
Good	154.8	153.4	145.2	163.8
Fair	130.8	151.6	143.8	157.0
Poor	129.0	134.8	130.4	146.6

[a] Scores are the sum of three trials on the dynamometer.

TABLE 3.—ANALYSIS OF VARIANCE FOR MOTIVE-INCENTIVE GROUPS

Source of Variance	SS	DF	MS	F
Groups	2,621.9	3	873.9	2.34[a]
Levels	28,632.4	3	9,544.1	-----
(Cells)	(32,824.0)	(15)		-----
Groups X Levels	1,569.7	9	174.4	0.47[b]
Within	23,872.8	64	373.0	-----
Total	56,696.8	79		

[a] $F = 2.75$ for significance at the 5 percent level.
[b] $F = 2.02$ for significance at the 5 percent level.

On the basis of studies done in other areas an assumption could be made that threat of electric shock, verbal encouragement, and knowledge of results would improve performance. The results of this experiment indicate, however, that on a simple task that requires neither endurance nor skill, there appears to be no difference in performance under the various motive-incentive conditions.

The apparent contradiction of Fleischman's study (1) can be explained. His primary objective was to design an experiment to obtain improvement. He selected a task that seemed most susceptible to the experimental treatment and loaded the experimental instructions. In the discussion of results, Fleischman states that while the differences were statistically significant, they were not large and should be interpreted with caution. Further he did not compare different types of motive-incentive conditions but utilized several motive-incentive conditions simultaneously in the experimental group. Ulrich and Burke found no differences in performance between the two types of motivational stress, which is in agreement with the present study.

The explanation for differences between performance on a physical task of this nature and performance on verbal material may be due to the nature of

the physical test itself. Subjects in physical performance tests appear to be highly motivated, expressing a keen interest in their performance and the performance of others. It seems probable that the nature of simple tests of physical performance provides sufficient incentive to elicit maximal performance without additional motivation.

Summary and Conclusions

It was the purpose of this experiment to determine the effects of four types of motive-incentive conditions on grip strength. Eighty male subjects were divided into four subgroups, all groups being matched on the basis of a preliminary grip test. Group one was simply told to do as well as possible on the retest, group two was verbally exhorted to improve, group three was given the results of the previous test and was allowed to watch the dynamometer dial on the retest, and group four was threatened with electric shock for failure to improve.

There were no differences in performance between the four motive-incentive conditions, and no differences in performance between groups at the various performance levels. These results have practical implications for measurement programs in physical education. In the past, very little attention has been directed to the control of motivation when testing strength. This study suggests that as long as an effort is made to have subjects understand the importance of giving a maximum effort, no additional incentive is necessary. Further, additional incentive, if given, should not bias results.

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Reaction Time and Movement Time in Four Large Muscle Movements[1]

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Abstract

The relation between RT and MT was determined in 70 male college students. Four types of discrete movement were studied. Reliabilities were high, namely r = .87 to .95 uncorrected. The correlations between RT and MT ranged from r = —.06 to .23, and none was statistically significant. It was concluded that individual differences in ability to react quickly and ability to move quickly are almost entirely unrelated.

A SIGNIFICANT CORRELATION between reaction time (RT) and movement time (MT) for short movements has recently been reported by Pierson (3) and by Youngen (4). Youngen stated that her findings tend to contradict the results of earlier research workers. Pierson has reviewed the literature, which shows in general other experimenters have usually found little or no relation between these variables, although both positive and negative correlations have sometimes been found. No clear explanation of the possible reasons for the divergence of the results in different investigations has been proposed. Youngen states that "the release of the reaction key may have been affected by the muscles used in moving the arm." Pierson suggests that the correlation may be lower in college students than in other age groups, but offers no statistical analysis in support of his position, nor does he mention it in his conclusions. Apparently his subjects were given no warning signal or standard foreperiod: Youngen employed the usual randomized one- to four-sec. preparatory interval. Both used a forward arm thrusting movement.

It is conceivable that the relationship might depend on the kind of movement. For example, one can study different limbs (therefore different muscles), and one can study the relation when the movement is made in a backward rather than a forward direction. If the results should be consistent under all of these conditions, a broader generalization should be possible. If, using the same sample of subjects, the relationship should be different with the different muscles, limbs, or directions, this might afford a clue to the reason for the conflicting reports in the literature. The present study was designed to make this approach.

Methodology

Subjects. Seventy male undergraduate volunteers were secured from physical education and ROTC classes at the University of California. The mean

[1]From the Research Laboratory of the Department of Physical Education.

age was 23.7 years ($\sigma = 3.99$). No specialized athletes (such as boxers, soccer players, tennis players, or weight lifters) were used. Each person was tested during two separate one and one-half hour periods, approximately one week apart.

Timing Instruments. Two electric chronoscopes of the S-1 type were employed, using the high precision D.C. clutch circuits described by Henry (1). Using his calibration method, the variable error of each instrument was found to be slightly less than .001 sec. Readings were made to the nearest .001 sec. by interpolation within the .01 sec. scale divisions.

Arm Movements. A reaction key (a double-throw microswitch) was attached to a wooden block which could be adjusted on the supporting framework, so that it was at shoulder height for each subject. A roller attached to the switch protruded about 4 mm. above the surface of the block so that the subject's lightly clenched fist depressed it when he rested his preferred arm (held straight out sideways in the horizontal position) in preparation for reacting to the stimulus. The subject was given the verbal command "Ready!" and after the lapse of a time period randomly varied between one and four seconds, the stimulus sound was given. The movement was a horizontal forward arm swing from the shoulder, with the elbow joint extended and stiff throughout. At the start, the fist slid off the reaction key.

The stimulus consisted of a loud click produced when the experimenter started the first chronograph by snapping on the starting switch, which was placed just behind his head to improve audibility. The subject reacted by making the movement, which of course involved moving his hand off of the reaction key. This act stopped the first chronoscope (RT) and started the second one (MT). When the subject's arm had completed approximately 90° of his forward arm swing (made a maximum speed), his clenched first struck the target string, which dislodged a plastic clip holding the contacts together in a second microswitch. This resulted in stopping the MT chronoscope. He completed the movement with a normal follow-through. No twisting of the body was permitted prior to the follow-through. After performing three practice trials with the arm swing forward, which served as a preliminary warmup period, ten test trials were completed by the subject with a one-minute interval between each trial. For the arm swing backward, the position of the reaction key and target string were reversed as compared with the first type of movement. The number of trials was the same. In both movements, the hand traveled 80 cm. along the arc of the swing, between the starting position and the timing string.

Leg Movements. The subject stood in an upright position with his preferred leg placed so that his heel lightly pressed a reaction key which was connected to the chronoscope circuit. The heel of his other leg (which supported most of his body weight) was against a fixed wooden support, 25 cm. in front of the kicking foot (see Figure I). After the appearance of a warning light, the subject reacted to the stimulus light which flashed on after a random delay that ranged between one and four seconds. On perceiv-

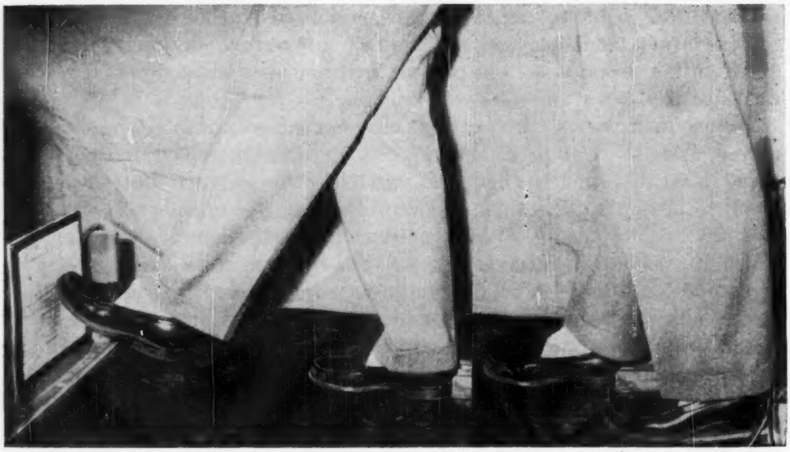

FIGURE I. Leg forward movement. At the right side of the figure, the heel of the kicking foot (in this case, the left one) is in the starting position, pressed back against the reaction key. On the left, the foot has swung forward to strike the target and pull out the string behind it. The heel of the supporting foot has remained stationary against the backstop.

ing the sudden blink of the stimulus light, he swung the preferred leg with maximal speed to strike a square padded target 70 cm. from the commencement of the swing and made a normal follow through. The RT chronoscope started with the signal light. As soon as the heel left the reaction key the RT chronoscope stopped, while the MT chronoscope started up in order to record the leg movement time. The target was hinged to the floor. Behind it was a taut string attached to a pull-out switch. Touching the target stopped the MT chronoscope. To measure the leg backward RT and MT, the subject swung his extended leg backward to strike the square rubber pad with the heel of his kicking foot. As with the leg forward movement, the distance traveled was 70 cm. Practice and ten trials were given as in the arm movement tests.

Results and Discussion

It is noteworthy that all of the reliability coefficients are relatively high (see Table 1). Most of them are above .91 for the half-test values. The two lowest ($r = .87$ and $.88$) are .93 or higher when adjusted to the full test values by the Spearman-Brown method.

With $N = 70$, a correlation must be at least $r = .236$ in order to be significantly different from zero at the 5 percent level of confidence. The data in Table 1 show that none of the obtained correlations between RT and MT are statistically significant. For one of the movements (leg forward) the process of correction for attenuation raises the correlation to a value just

TABLE 1.—DESCRIPTIVE STATISTICS AND CORRELATIONS

	Arm Fwd.	Arm Back.	Leg Fwd.	Leg Back.
Reaction Time				
M (sec.)	.225	.221	.289	.303
σ	.034	.030	.050	.042
r^{a}_{11}	.869	.877	.946	.911
Movement Time				
M (sec.)	.151	.156	.135	.139
σ	.027	.022	.014	.016
r^{a}_{11}	.940	.911	.932	.929
Correlations (RT vs. MT)				
Total Score				
Raw	.089	.136	.229	—.024
Corrected[b]	.094	.144	.236	—.025
Split half				
Odd (raw)	.067	.189	.233	—.015
Even (raw)	.062	.092	.220	—.063
Corrected (av.)[c]	.072	.157	.241	—.043

[a] Odd-even reliability coefficients, uncorrected.
[b] The reliability coefficients as tabled have been corrected to the full-test values by the Spearman-Brown method before computing the corrections for attenuation.
[c] The correlations for the odd-numbered trials and even-numbered trials have been averaged by the Z transformation method after correction for attenuation using the tabled reliability values.

over the required value, but there is no assurance that one is justified in considering that it is thereby made statistically significant. The correlations between RT and MT for the other movements are very low. Even after correction for attenuation, they lie between .157 and —.043.

The position is taken in the present article that it matters very little whether the correlations are just above or below some arbitrary cut-off point for statistical significance. The finding that has important implications is that for all four movements the relation is so low as to be of no practical consequence. The reader is reminded that the amount of individual difference variance accounted for by a correlation is related to r^2 rather than the unsquared r.

It is of technical interest to compare the corrected correlations (Table 1) as computed by two methods, which might or might not yield similar results. Using the first method, the raw correlations between RT and MT have been computed from the average scores of all trials by each subject. The reliability coefficients given in the table have been expanded to the full-test values by the Spearman-Brown method before making the correction for attenuation.

Using the second method, the averages of the odd-numbered trials only have been used for one estimate, and the even-numbered trials have been employed for another estimate. These values (shown in Table 1) have subsequently both been corrected for attenuation, using the tabled values of the reliability coefficients without the need of applying the Spearman-Brown adjustment. The coefficients obtained for the odd-numbered trials and the even-

numbered trials have then been averaged by the Z transformation method, yielding the results shown in the bottom line of the table. In the present study, the results are about the same with each of the methods.

The results using the arm swing forward can be compared with the RT-MT correlation recently reported by Henry and Whitley (2). The movement and apparatus are similar in the two experiments, although the samples of subjects are different. They reported a corrected correlation of $r = .059$; in the present experiment it is .094. The agreement is therefore excellent. In both experiments, the reaction is made by the muscles that move the arm.

The movement used by Pierson was different from any of the four used in the present study. It is possible that the particular movement and/or method he used is responsible for his finding of a correlation between the RT and MT variables. However, his results do not seem to be typical of what may ordinarily be expected. In this connection, it is noted that Youngen's finding of $r = .27$ for the RT-MT correlation in 47 women athletes and .25 in 75 women nonathletes is not different in principle from the present results. When her correlations are squared, it can be seen that there is only 7 percent of individual difference variance held in common between RT and MT.

Conclusions

Individual differences in ability to react quickly have little or nothing in common with individual differences in ability to move the arms or legs rapidly. It is believed that considerable generalization is justified as compared with previous experiments, since four types of movements and two types of stimuli were studied.

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(Submitted 4/14/60)

Relationship between Participation in Interschool Sports and Extraclass Play Activities in College

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Abstract

Questionnaires were administered to 859 freshmen at the University of Florida to determine the nature and extent of their participation in high school and elementary school sports and the nature and extent of their play in extraclass sports during their freshman year in college. Statistical analysis was made of differences in play characteristics during the freshman year of students with varying types of interscholastic experience, of students who participated in specific types of interscholastic sports, and of students with different degrees of leadership and skill ability in interscholastic sports.

MUCH HAS BEEN said about the values of interschool athletics. One potential value that is constantly being overlooked is the development of a strong desire to engage in physical activity in the post-high-school period. In a day when the need for increased participation in physical exercise is accepted on all sides, such carry-over from interscholastic sports might well be one of the most significant contributions that these activities can make.

Whether or not there is such carry-over is of significance to many. It is important to the coach in justifying his athletic program. It is important to the physical education teacher in attributing carry-over value to activities in the school program. It is important to the recreation worker who continually strives to increase participation in community-wide athletic sports programs. It is important to the educator who must evaluate continuously the many offerings in the school program in the light of the total development of the student. This study was made to determine the value of aspects of interschool sports of self-motivated participation in physical activities in the year following graduation from high school.

Statement of the Problem

The purpose of this study was to determine the significance of the relationships that existed between various levels of participation in interschool sports below the college level and the nature, extent, and types of extraclass play engaged in during the freshman year in college. The study also investigated differences in characteristics of play of freshmen who had engaged in each of the sports sponsored by the Florida High School Activities Association, and differences in characteristics of play between participants in high school varsity sports and athletes who had earned exceptional honors and distinctions in these varsity sports.

It is well to point out that the college freshmen in this study had rather ideal opportunities to engage in play activities when, where and how they chose. At the University of Florida, a wealth of indoor and outdoor areas and facilities were available for unsupervised play several hours per day. Play equipment was easily accessible to the student at no cost. A varied intramural program provided ample chance for competitive sports. Sports activity clubs were available for the enthusiast in many activity areas. Thus the problem studied involved an examination of carry-over from interschool sports to the year following graduation from high school in an environment conducive to participation in physical activities of a play nature.

Procedures

Data in this study were collected by the questionnaire technique. A detailed and objective instrument was developed to secure biographical information, data concerning interschool sports participation, and data pertinent to the play patterns shown during the freshman year in college. In order to assure reasonable accuracy in the final measurement, the questionnaire was administered to a select group of professional physical education students, and various items were altered on the basis of difficulties in interpretation encountered. The final instrument was considered completely understandable by this group of students.

This final questionnaire was administered to 859 male freshmen enrolled at the University of Florida. An effort was made to control certain conditions that could feasibly influence the extent of carry-over that might be found. The group of students studied was limited to those enrolled in the general college, thereby assuring a relatively common academic program during the period being studied. This group was further limited to those students who had enrolled in the university at the beginning of the fall semester after having graduated from high school the previous spring. Thus the length of time which had elapsed between interschool experience and enrollment at the university was held somewhat constant. The group studied was also limited to those who had not participated in organized intercollegiate sports as a freshman and who had attended college continuously during the freshman year.

The questionnaire was administered to the selected students during the last two weeks of the spring semester, which were also the last two weeks of their freshman year in college. After an orientation and instruction session in which the nature, purpose, and problems of administering the instrument were explained and discussed, staff members of the Department of Required Physical Education for Men distributed questionnaires to eligible students in their classes, supervised completion of the questionnaire by the student, and collected the completed instruments. The following information was requested of each student:

1. The level of participation in interschool athletics before entering college. Possible levels included:

a. varsity participation with previous experience as a member of a B-team, junior high school team, and/or elementary school team,

b. varsity participation with no previous interschool experience,

c. B-team, junior high school team, and/or elementary school team with no varsity experience, and

d. no interschool experience in any sport.

2. The specific sport engaged in. These included those sports sponsored by the Florida High School Activities Association—basketball, football, baseball, track and field, swimming, golf, tennis, and other sports. Wrestling, volleyball, and soccer were mentioned most frequently in this category.

3. Special honors and awards earned in each of these activities. Acceptable honors included captain of a sport, most valuable player award, all-conference or all-state award, member of a conference, district, or state championship team, or individual champion in a sport at the conference, district, or state level.

4. The average amount of time devoted to extraclass activities of a play nature during the freshman year in college.

5. The proportion of time devoted to extraclass play activities in intramural sports, activity clubs, and unsupervised play.

6. The frequency of particiption in specific physical activities available at the University of Florida. These activities included archery, bait casting, baseball, basketball, bowling, gator ball, golf, handball, judo, lacrosse, soccer, social dance, softball, square dance, swimming, tennis, touch football, track and field, tumbling and gymnastics, volleyball, weight lifting, and weight training.

The data thus collected were then transferred to IBM cards, and machine sorting techniques were employed to place the data in convenient groupings for further study.

Analysis and Interpretation of Data

The data in this study were analyzed in terms of the differences in play characteristics of the freshman with selected types of interschool athletic experience, the differences in play characteristics of freshmen with experience in specific interschool varsity sports, and the differences in play characteristics of freshmen with varsity experience in specific high school sports and athletes who had achieved honors as a result of participation in varsity sports.

Differences in Play Characteristics by Type of Interschool Sports Experience

The characteristics of play during the freshman year were studied according to the extent of participation, the nature of the participation, and the nature of the activities engaged in.

Extent of participation. This factor was determined as the average number of hours per week that each student estimated he had devoted to all extraclass physical exercise during the freshman year. Table 1 shows the proportion of students in each interscholastic experience classification, by sport, that participated a given number of hours per week.

It is interesting to note the number of students in each sport that had participated in high school varsity sports without previous experience in organized interschool sports at a lower level. Thirteen of 123 varsity basketball players, 44 of 204 varsity football players, 24 of 92 varsity baseball players,

TABLE 1.—WEEKLY PARTICIPATION OF GROUPS WITH VARIOUS TYPES OF INTERSCHOLASTIC EXPERIENCE

Extent of Interscholastic Experience[a]	N	Proportion Per Group: 10 or more hours weekly	5-9 hours weekly	3-4 hours weekly	1-2 hours weekly	no hours weekly
No Experience	248	.012	.076	.318	.338	.254
Basketball						
Group A	110	.036	.109	.472	.272	.109
Group B	13	.153	.153	.300	.153	.230
Group C	194	.025	.118	.500	.273	.082
Total	317	.034	.116	.482	.268	.097
Football						
Group A	160	.050	.106	.450	.312	.081
Group B	44	.045	.113	.500	.204	.136
Group C	156	.032	.121	.455	.256	.134
Total	360	.041	.113	.458	.275	.111
Baseball						
Group A	68	.088	.161	.500	.205	.044
Group B	24	.041	.166	.291	.375	.125
Group C	157	.031	.127	.477	.235	.127
Total	249	.048	.140	.465	.240	.104
Track and Field						
Group A	70	.057	.114	.442	.271	.114
Group B	88	.011	.113	.545	.261	.068
Group C	87	.057	.114	.448	.275	.103
Total	245	.040	.114	.481	.269	.093
Swimming						
Group A	18	.055	.166	.555	.111	.111
Group B	31	.032	.096	.580	.193	.096
Group C	32	.093	.156	.343	.312	.093
Total	81	.061	.135	.481	.222	.098
Golf						
Group A	10	.000	.200	.100	.500	.200
Group B	19	.052	.052	.736	.052	.105
Group C	5	.000	.200	.400	.200	.200
Total	34	.029	.117	.500	.205	.147
Tennis						
Group A	7	.000	.285	.428	.285	.000
Group B	21	.000	.142	.571	.142	.142
Group C	10	.000	.100	.100	.700	.100
Total	38	.000	.157	.421	.315	.105
Other						
Group A	16	.062	.125	.375	.312	.125
Group B	31	.032	.193	.451	.129	.193
Group C	46	.021	.065	.652	.239	.021
Total	93	.032	.118	.537	.215	.096

[a] Group A: Varsity and junior high, B-team, and/or elementary school participation.
Group B: Varsity participation only.
Group C: Junior high, B-team, and/or elementary school participation only.

88 of 158 varsity track and field participants, 31 of 49 varsity swimmers, 19 of 29 varsity golfers, and 21 of 28 varsity tennis players indicated no experience previous to the varsity level. The major team sports evidently demand participation at a lower school level, the minor team sports considerably less participation, and the individual sports even less participation still.

Almost half the students with previous interschool athletic experience engaged in physical activities beyond required classes three to four hours per week. Approximately 15 percent of this group spent more than five hours per week in these activities, while about 35 percent devoted two or less hours to them. These figures differ markedly from those of the 248 students with no athletic experience in any sport. Thirty-two percent of this group indicated that three to four hours were devoted to play per week, 9 percent exceeded this weekly allotment, and 59 percent played less than three hours per week.

The chi-square test of homogeneity was used to test the hypothesis that the four groups of students divided according to types of interscholastic athletic experience were alike actually in the proportion of their total numbers who devoted given hours to play activities each week. The proportions found in Table 1 indicate rather wide differences between these groups, particularly between the athlete and the nonathlete. This test was made to determine whether or not these differences could actually be attributed to chance.

Table 2 shows the statistical significance of the chi squares found. That for tennis was significant at the 10 percent level, for golf at the 5 percent level. Those for all other sports were significant at beyond the 1 percent level. The hypothesis that the four groups of students were homogeneous, or alike, in the extent of participation during the freshman year was rejected with confidence in all sports except tennis.

Nature of College Participation. The proportion of students in each experience group that participated given percentages of time in intramural sports, club activities, and unsupervised play is shown in Table 3. About 14 percent of the group with interschool experience devoted more than two-

TABLE 2.—SIGNIFICANCE OF RELATIONSHIPS BETWEEN LEVEL OF INTERSCHOLASTIC PARTICIPATION AND EXTENT OF PLAY DURING FRESHMAN YEAR IN COLLEGE

Interscholastic Sport	N	Degrees of Freedom	χ^2	Level of Significance
Basketball	565	12	48.87	1%
Football	608	12	55.76	1%
Baseball	497	12	48.06	1%
Track and field	493	12	40.50	1%
Swimming	329	12	30.31	1%
Golf	282	12	23.25	5%
Tennis	286	12	19.60	10%
Other	341	12	34.97	1%

TABLE 3.—PROPORTION OF GROUPS WITH VARYING TYPES OF INTERSCHOLASTIC EXPERIENCE WHO PARTICIPATED IN SPECIFIC KINDS OF PLAY DURING THE FRESHMAN YEAR

	Proportion of Total Time in								
	Intramurals			Club Activities			Unsupervised Play		
Extent of Interscholastic Experience[a]	more than ⅔	⅓ to ⅔	less than ⅓	more than ⅔	⅓ to ⅔	less than ⅓	more than ⅔	⅓ to ⅔	less than ⅓
No Experience	.027	.086	.886	.027	.050	.921	.792	.121	.086
Basketball									
Group A[a]	.181	.218	.600	.009	.072	.918	.509	.245	.245
Group B[b]	.153	.461	.384	.000	.153	.846	.307	.538	.153
Group C[c]	.116	.232	.651	.015	.075	.909	.565	.267	.166
Total	.140	.236	.623	.012	.077	.909	.535	.271	.193
Football									
Group A	.186	.198	.614	.012	.080	.906	.509	.248	.242
Group B	.090	.227	.681	.022	.068	.909	.636	.227	.136
Group C	.089	.216	.694	.012	.089	.898	.582	.286	.127
Total	.132	.209	.657	.013	.082	.903	.558	.262	.179
Baseball									
Group A	.217	.260	.521	.014	.043	.942	.478	.231	.289
Group B	.200	.200	.600	.040	.040	.920	.560	.200	.240
Group C	.156	.262	.581	.012	.106	.881	.475	.318	.206
Total	.177	.255	.566	.015	.082	.901	.484	.283	.232
Track and Field									
Group A	.112	.239	.647	.014	.154	.830	.464	.338	.197
Group B	.078	.179	.741	.000	.056	.943	.696	.213	.089
Group C	.155	.222	.622	.022	.100	.877	.522	.233	.244
Total	.116	.212	.672	.012	.100	.888	.568	.256	.176
Swimming									
Group A	.263	.210	.526	.000	.105	.894	.421	.315	.263
Group B	.096	.096	.806	.064	.000	.935	.709	.129	.161
Group C	.117	.205	.676	.000	.176	.823	.529	.294	.176
Total	.142	.166	.690	.023	.095	.880	.571	.238	.190
Golf									
Group A	.100	.000	.900	.000	.100	.900	.800	.000	.200
Group B	.238	.142	.619	.047	.047	.904	.476	.238	.285
Group C	.200	.000	.800	.000	.000	1.000	.800	.000	.200
Total	.194	.083	.722	.027	.055	.916	.611	.138	.250
Tennis									
Group A	.000	.428	.571	.000	.142	.857	.428	.571	.000
Group B	.142	.285	.571	.000	.047	.952	.571	.285	.142
Group C	.100	.200	.700	.000	.200	.800	.400	.400	.200
Total	.105	.289	.605	.000	.105	.895	.500	.368	.132
Other									
Group A	.062	.312	.625	.000	.125	.875	.437	.437	.125
Group B	.060	.242	.696	.090	.121	.787	.454	.363	.181
Group C	.125	.187	.687	.000	.062	.937	.604	.208	.187
Total	.092	.226	.680	.030	.092	.876	.525	.298	.175

[a] Group A: Varsity and junior high, B-team and/or elementary school participation.
[b] Group B: Varsity participation only.
[c] Group C: Junior high, B-team, or elementary school participation only.

thirds of their total extraclass play time to intramurals, while only 3 percent of the nonexperienced group played in intramurals this much. Some 25 percent of the athletic groups spent one-third to two-thirds of their play time in this type of participation, while the nonathletic group showed 9 percent. Approximately 60 percent of those with previous interscholastic experience gave less than one-third of their total time to intramurals, and 87 percent of the nonexperienced did likewise. The students with no athletic experience spent considerably less time in intramural activities.

Differences in proportions of the four groups in club activities were quite small. Since these two types of participation, plus that of unsupervised play, constituted the total opportunities for extraclass play on the campus, the trends observed for intramural play were reversed for unsupervised play. Those with no high school athletic experience devoted a much larger proportion of their time to unsupervised play when compared to those with experience.

Table 4 shows the statistical significance of these differences. The tests for homogeneity yielded chi squares that were significant at beyond the 1 percent level of confidence in all sports when intramural participation during the freshman year was considered. Those students who had experience in interschool sports before entering college participated significantly more in intramural sports than did those with no experience.

Participation in club activities yielded entirely different results. With the exception of swimming, which was significant at the 5 percent level, the four experience groups were found to be alike in this characteristic. The significance of the difference found in swimming might be a result of the exceptional interest in this activity on a club basis among University of Florida students.

The extent of participation in unsupervised play reversed the significance found in intramurals. All chi squares obtained were significant—golf at the 2 percent level and all other sports at the 1 percent level. Students with no interscholastic athletic experience devoted a higher proportion of their play time to unsupervised play than did those with such experience.

Nature of Activities. Data concerning the specific activities in which students participated during the freshman year were originally collected specific to each activity. For convenience, these data were then combined to represent four general types of activities. Archery, bait casting, bowling, social dance, square dance, and swimming were termed *recreation-oriented.* Weight training, tumbling and gymnastics, judo, and weight lifting were considered *physical fitness-oriented.* Track and field, golf, handball, and tennis were grouped as *competitive individual or dual;* and baseball, basketball, gator ball, lacrosse, soccer, softball, touch football, and volleyball were considered *team sports.*

Table 5 shows the extent of participation in each of these four special types of activities. Proportions in this table are based on the total number

TABLE 4.—SIGNIFICANCE OF RELATIONSHIPS BETWEEN DEGREE OF INTERSCHOLASTIC PARTICIPATION AND TYPE OF PARTICIPATION IN FRESHMAN YEAR OF COLLEGE

Interscholastic Sport	Intramurals				Club Activities				Unsupervised Play			
	N	Degrees of Freedom	χ^2	Level of Significance	N	Degrees of Freedom	χ^2	Level of Significance	N	Degrees of Freedom	χ^2	Level of Significance
Basketball	576	6	61.30	1%	576	6	4.75	70%	576	6	51.68	1%
Football	617	6	53.75	1%	617	6	3.85	70%	617	6	46.44	1%
Baseball	509	6	69.88	1%	509	6	7.33	30%	509	6	57.56	1%
Track and Field	505	6	40.41	1%	505	6	12.55	10%	505	6	42.99	1%
Swimming	339	6	31.66	1%	339	6	13.62	5%	339	6	22.85	1%
Golf	291	6	24.81	1%	291	6	1.46	95%	291	6	15.15	2%
Tennis	293	6	25.34	1%	293	6	5.85	50%	293	6	22.56	1%
Other	352	6	66.39	1%	352	6	10.30	20%	352	6	31.06	1%

of choices available to the student and not on the number of students in each experience group. No definite trends are observable in these data.

Table 6 indicates the significance of the relationships between degree of participation in interscholastic sports and extent of participation in each of these four special types of activities. The chi-square test for students with or without golf experience was significant at the 5 percent level when studied according to participation in recreation-oriented activities. All other sports yielded nonsignificant chi-square values. With the exception of golf, the extent of interscholastic participation had little influence on participation in recreation-oriented activities during the freshman year in college.

All obtained chi squares found between the experience groups and the extent of participation in physical fitness-oriented activities were nonsignificant. The hypothesis that these four groups were alike in participation in physical fitness-oriented activities was retained.

The same general conclusion was reached for participation in competitive individual and dual activities with the exception of golf, which showed a significant difference at the 1 percent level of confidence. Apparently those students with interschool golf experience show a strong tendency to engage in individual and dual activities as well as in recreation-oriented activities.

The hypothesis that the four groups with varying experiences in interschool sports were alike in their participation in team sports during the freshman year was rejected for all sports except golf and tennis. The four groups were not alike for those with experience in basketball, football, baseball, track and field, swimming, and other sports. Those with such experiences participated significantly more in team sports than did those without it.

Examination of Tables 1, 3, and 5 showed no consistent trends in differences in proportions between the three experience groups that had participated in interschool sports in some manner. Evidently the type of such participation had little bearing on play characteristics in the first year of college. Since no trends were evident, no further statistical analysis was made of specific differences between these three groups.

Differences in Play Characteristics by Type of Interschool Sport

The interschool sports in which students participated were arranged in three groups to facilitate interpretation. Football and basketball were considered major team sports. Baseball, track and field, and swimming were classified as minor team sports. Golf and tennis were considered individual and dual sports. This part of the study involved the testing for significance of differences in the play characteristics of the freshmen studied who had participated as a varsity team member in one of these three types of sports previous to entering college.

The proportion of the total number of students in each of the three groups with selected characteristics of play are shown in Table 7. In terms of average weekly participation, those from both major and minor team sports

TABLE 5.—EXTENT OF PARTICIPATION IN SPECIFIC TYPES OF ACTIVITIES OF GROUPS WITH VARYING TYPES OF INTERSCHOLASTIC EXPERIENCE

Interscholastic Experience[a]	Recreation-Oriented				Physical-Fitness-Oriented				Competitive Individual and Dual				Team Sports			
	N	Seldom	Moderately	Frequently	N	Seldom	Moderately	Frequently	N	Seldom	Moderately	Frequently	N	Seldom	Moderately	Frequently
No Interscholastics	1644	.055	.115	.081	822	.053	.059	.038	1096	.094	.096	.060	2192	.083	.114	.029
Basketball																
Group A	678	.038	.110	.070	339	.079	.070	.029	452	.117	.152	.086	904	.076	.168	.101
Group B	78	.076	.179	.051	39	.025	.128	.000	52	.115	.230	.057	104	.038	.269	.076
Group C	1248	.065	.139	.094	624	.081	.107	.049	832	.115	.164	.114	1664	.105	.173	.087
Total	2004	.056	.131	.084	1002	.078	.095	.040	1336	.116	.163	.102	2672	.092	.175	.091
Football																
Group A	984	.056	.137	.093	492	.060	.138	.063	656	.125	.163	.105	1312	.087	.195	.097
Group B	264	.049	.098	.064	132	.037	.090	.060	176	.130	.113	.096	352	.073	.147	.082
Group C	984	.066	.139	.084	492	.087	.097	.048	656	.106	.160	.117	1312	.092	.166	.076
Total	2232	.060	.133	.086	1116	.069	.114	.056	1488	.117	.155	.109	2976	.088	.177	.086
Baseball																
Group A	420	.073	.169	.080	210	.095	.090	.038	280	.128	.167	.089	560	.082	.169	.148
Group B	150	.060	.100	.106	75	.080	.053	.066	100	.140	.120	.090	200	.100	.175	.110
Group C	996	.060	.137	.101	498	.092	.106	.052	664	.128	.176	.115	1328	.110	.188	.092
Total	1566	.063	.142	.096	783	.091	.097	.049	1044	.129	.168	.106	2088	.102	.181	.109
Track and Field																
Group A	438	.061	.127	.073	219	.082	.150	.086	292	.106	.174	.113	584	.089	.184	.078
Group B	546	.067	.161	.086	273	.084	.120	.054	364	.140	.197	.109	728	.100	.164	.101
Group C	558	.060	.132	.103	279	.075	.114	.050	372	.115	.153	.096	744	.099	.202	.079
Total	1542	.063	.141	.088	771	.080	.127	.062	1028	.121	.175	.106	2056	.096	.184	.087

Interscholastic Experience	Recreation-Oriented				Physical-Fitness-Oriented				Competitive Individual and Dual				Team Sports			
	N	Seldom	Moderately	Frequently	N	Seldom	Moderately	Frequently	N	Seldom	Moderately	Frequently	N	Seldom	Moderately	Frequently
Swimming																
Group A	114	.087	.087	.140	57	.157	.157	.052	76	.118	.144	.092	152	.125	.171	.059
Group B	186	.053	.161	.134	93	.118	.096	.053	124	.153	.169	.064	248	.100	.173	.076
Group C	216	.060	.111	.125	108	.074	.120	.074	144	.097	.159	.125	288	.065	.163	.104
Total	516	.063	.124	.131	258	.108	.120	.062	344	.122	.159	.095	688	.091	.168	.084
Golf																
Group A	66	.075	.090	.075	33	.060	.030	.030	44	.090	.068	.227	88	.102	.125	.034
Group B	132	.037	.113	.196	66	.090	.090	.045	88	.125	.215	.181	176	.096	.232	.056
Group C	30	.100	.066	.066	15	.133	.000	.000	20	.000	.000	.215	40	.100	.025	.025
Total	228	.057	.100	.144	114	.087	.061	.035	152	.098	.144	.203	304	.098	.174	.046
Tennis																
Group A	42	.047	.142	.047	21	.047	.047	.095	28	.107	.285	.142	56	.053	.232	.071
Group B	126	.079	.126	.095	63	.126	.000	.031	84	.130	.214	.154	168	.113	.166	.065
Group C	66	.045	.106	.090	33	.060	.060	.060	44	.022	.045	.113	88	.056	.079	.022
Total	234	.064	.123	.085	117	.094	.025	.051	156	.096	.179	.141	312	.086	.153	.054
Other																
Group A	96	.083	.156	.104	48	.083	.083	.000	64	.171	.218	.078	128	.125	.218	.125
Group B	204	.073	.166	.102	102	.098	.127	.039	136	.102	.213	.095	272	.102	.172	.091
Group C	288	.079	.163	.104	144	.090	.090	.027	192	.151	.130	.109	384	.106	.223	.083
Total	588	.078	.163	.103	294	.091	.102	.027	392	.137	.173	.099	784	.108	.205	.093

[a] Group A—Varsity and junior high, B-team, and/or elementary school participation.
Group B—Varsity participation only.
Group C—Junior high, B-team, or elementary school participation only.

TABLE 6.—SIGNIFICANCE OF RELATIONSHIPS BETWEEN DEGREE OF INTERSCHOLASTIC EXPERIENCE AND DEGREE OF PARTICIPATION IN SPECIFIC TYPES OF ACTIVITIES

Interscholastic Sport	Recreation-Oriented				Physical Fitness-Oriented				Individual and Dual Competitive				Team Sports			
	N	Degrees of Freedom	χ^2	Level of Significance	N	Degrees of Freedom	χ^2	Level of Significance	N	Degrees of Freedom	χ^2	Level of Significance	N	Degrees of Freedom	χ^2	Level of Significance
Basketball	962	6	4.03	70%	341	6	8.02	30%	786	6	8.31	30%	1459	6	51.22	1%
Football	1039	6	1.50	98%	394	6	9.90	20%	846	6	7.92	30%	1545	6	40.85	1%
Baseball	889	6	5.35	50%	312	6	3.45	80%	698	6	4.49	98%	1319	6	60.92	1%
Track and Field	868	6	3.47	80%	333	6	2.92	90%	690	6	5.30	50%	1255	6	34.53	1%
Swimming	580	6	7.99	30%	200	6	2.86	90%	406	6	5.33	50%	735	6	25.61	1%
Golf	434	6	13.95	5%	146	6	4.13	70%	344	6	25.86	1%	595	6	6.79	50%
Tennis	479	6	1.58	98%	145	6	10.41	20%	341	6	10.00	20%	590	6	5.54	50%
Other	618	6	.47	99%	190	6	5.66	50%	437	6	6.72	50%	817	6	18.96	1%

TABLE 7.—PROPORTION OF STUDENTS CLASSIFIED ACCORDING TO TYPE OF INTERSCHOLASTIC SPORTS AND HONORS RECEIVED WHO DEMONSTRATED PARTICULAR CHARACTERISTICS OF PLAY

Characteristics of Play in Freshman Year			High School Participation and Honors				
			Type of varsity sport			Honors	
			Major team sports	Minor team sports	Individual and dual sports	Varsity with honors	Varsity—no honors
Average Weekly Participation		N	328	304	59	281	730
		10 or more hours	.048	.047	.018	.043	.045
		5-9 hours	.110	.130	.140	.128	.125
		3-4 hours	.459	.495	.526	.502	.477
		1-2 hours	.278	.244	.193	.228	.252
		less than one hour	.104	.084	.123	.100	.101
Type of Participation	Intramurals	N	328	304	59	284	740
		more than ⅔	.171	.141	.153	.204	.150
		⅓ to ⅔	.220	.207	.203	.246	.216
		less than ⅓	.610	.651	.644	.549	.634
	Club Activities	N	328	.304	59	284	740
		more than ⅔	.012	.016	.017	.004	.018
		⅓ to ⅔	.079	.072	.068	.085	.078
		less than ⅓	.909	.911	.915	.912	.904
	Unsupervised play	N	328	304	59	284	740
		more than ⅔	.518	.566	.559	.479	.536
		⅓ to ⅔	.256	.243	.254	.278	.259
		less than ⅓	.226	.191	.186	.243	.204
Type of Activity Participated in	Recreation oriented	N	2004	1854	366	1716	4224
		seldom	.050	.066	.060	.065	.058
		moderately	.124	.145	.117	.135	.133
		frequently	.080	.091	.122	.087	.089
	Physical fitness oriented	N	1002	927	183	858	2112
		seldom	.062	.093	.092	.083	.079
		moderately	.108	.115	.043	.111	.106
		frequently	.048	.059	.043	.051	.053
	Competitive individual and dual	N	1336	1236	244	1144	2816
		seldom	.122	.129	.118	.112	.125
		moderately	.155	.173	.196	.175	.167
		frequently	.095	.098	.176	.101	.104
	Team sports	N	2672	2472	488	2288	5632
		seldom	.080	.095	.098	.092	.088
		moderately	.182	.172	.190	.183	.179
		frequently	.096	.102	.057	.105	.096

showed a slight tendency to participate more frequently than those with experience in individual and dual sports. All three groups showed approximately the same proportion of participants in intramurals, club activities, and unsupervised play. Some differences were observable in the types of activities engaged in during the freshman year. Those with varsity experience in golf and tennis tended to engage in recreation-oriented and competitive individual and dual activities more frequently, while those with varsity experience in major and minor team sports tended to engage in physical fitness-oriented activities and team sports more frequently.

Table 8 indicates the statistical significance of the differences in proportion of students in the three groups with different types of varsity experience. The hypothesis of homogeneity was retained for average weekly participation; participation in intramurals, club activities, and unsupervised play; and participation in all types of activities except team sports. The chi square obtained in the latter instance was significant at the 2 percent level of confidence. This significance was due in large measure to the relatively large dif-

TABLE 8.—SIGNIFICANCE OF RELATIONSHIPS BETWEEN TYPE OF VARSITY SPORTS EXPERIENCE AND HONORS ACHIEVED AND CHARACTERISTICS OF PLAY IN FRESHMAN YEAR

Characteristics of Play in Freshman Year		Type of Varsity Sport N	Degrees of Freedom	χ^2	Level of Significance	Honors N	Degrees of Freedom	χ^2	Level of Significance
Average Weekly Participation		683	8	5.27	30%	964	4	.96	95%
Type of Participation	Intramurals	691	4	1.46	90%	975	4	5.96	50%
	Club Activities	691	4	.36	99%	975	4	2.35	80%
	Unsupervised Play	691	4	1.84	80%	975	4	3.38	70%
Type of Activity Participated in	Recreation Oriented	1186	4	5.93	20%	1678	4	.68	98%
	Physical Fitness Oriented	503	4	9.36	10%	713	4	.13	99%
	Competitive Individual and dual	1116	4	7.47	20%	1559	4	1.46	90%
	Team sports	2043	4	13.14	2%	2913	4	.61	98%

ference in proportions of students that engaged in team sports frequently. Those with varsity experience in individual and dual sports participated considerably less than did those with team sports experience.

Difference in Play Characteristics of Varsity Participants and Varsity Participants with Honors

The characteristics of play during the freshman year were examined for all varsity participants in high school sports and members of this group that received special honors and awards as a result of this participation. This phase of the study was made to determine whether or not any differences in characteristics of play were shown by those who were leaders and exceptionally well-skilled when compared with all those who engaged in varsity sports.

Table 7 shows the striking similarity in the proportion of students in the two groups that were characterized by each factor of play studied. The chi-square tests for homogeneity shown in Table 8 give proof of the lack of significance of all differences in proportions for all characteristics of play studied. All observed differences could well have resulted from chance sampling.

Summary and Conclusions

Questionnaires were distributed to 859 male freshmen at the University of Florida near the end of their freshman year. Each student was requested to indicate his experience in interschool sports, including the level of participation, the specific sport in which this participation occurred, and special honors that were attained as a result of this participation. The student was also asked to indicate the average length of time devoted to extraclass play in the freshman year, the extent of participation in intramurals, activity clubs, and unsupervised play, and the extent of play in specific activities available on the campus. On the basis of the responses made by the freshmen, the following conclusions were reached:

1. Participation in interschool sports below the high school varsity level appeared to be a significant factor in becoming a member of a varsity team in basketball, football, and baseball.
2. Students who participated in interschool sports engaged in physical activity during their freshman year significantly more than did those with no such experience.
3. Those students with interschool sports experience in high school and in elementary school devoted a greater proportion of their extraclass play time to intramural sports.
4. Previous experience in athletics was not a significant factor in the proportion of the total extraclass play time devoted to activity clubs.
5. Students with no previous athletic experience devoted a greater proportion of their play time to unsupervised play.
6. No statistically significant differences were observed in the types of activities engaged in by students with varying types of precollege school ath-

letic experience except for those in golf and tennis. Golfers with experience in interschool programs participated in greater proportions in recreation-oriented activities and in competitive individual and dual actvities than did the inexperienced. Those with tennis experience participated in greater proportions in individual and dual activities during the freshman year.

7. Students with interschool sports experience in team sports engaged more frequently in team sports in their freshman year. In all other instances no observable differences existed in the play characteristics of students with experience in other types of interschool sports.

8. No significant differences were found in the play characteristics of students with high school varsity athletic experience and students who had gained honors as a result of participating in high school varsity sports.

(Submitted 4/8/60)

Research Abstracts

Prepared by the Research Abstracts Committee of the Research Council, D. B. VAN DALEN, Chairman

1. AMERICAN JOURNAL OF PSYCHIATRY. "Brain and Personality." *American Journal of Psychiatry* 10: 938-39; April 1960.

Intellectual capacity does not depend on brain size, although a certain minimum size is necessary for learning and adaptation. Within a given species the size of the brain varies directly with the size of the individual; man has from 230-250 g. of brain per foot of his length. The human brain attained its present anatomical complexity and functional potential at least 50,000 years ago. The functional potential of the human brain has probably never been fully used, although occasional individuals may have approached it. Civilization has set aside the laws of natural selection and cultural selection now exploits the brain. All races of Homo sapiens have essentially similar brains and are potentially equal in intellectual capacity.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

2. ANDERSEN, K. L.; BOLSTAD, A.; LØYNING, Y.; and IRVING, LAURENCE. "Physical Fitness of Arctic Indians." *Journal of Applied Physiology* 15: 645; July 1960.

The responses of Arctic Indians residing near Old Crow in the Yukon Territory to bicycling at submaximal and maximal levels were compared to sedentary men and athletes of Norwegian descent. The maximal oxygen intake was approximately the same for the Indians and sedentary Norwegians; however, the Norwegian athletes were capable of eliciting maximal oxygen intakes about 1.4 liters higher. The respiratory recovery times and the extra ventilation after performance of 1000 kgm in one minute were respectively: Indians—7.11 min., 82.6 liters (BTPS); nonathletes—7.61 min., 77.4 liters; and athletes—6.15 min., and 62.5 liters. Thus the Indians appear to react to short-term unfamiliar bicycle tests much the same as sedentary individuals. While the results of the study are interesting, one wonders how the Indians and Norwegians would have compared if they had been asked to perform long-term or endurance tasks familiar to the Indians and unfamiliar to the Norwegians, such as rapidly canoeing a long distance or hiking through the brush with a back-pack?—*E. R. Buskirk.*

3. BECKNER, GEORGE L., and WINSOR, TRAVIS. "Physiologic Response to Prolonged Exercise." *Journal of the Association for Physical and Mental Rehabilitation* 14: 106-10; July-August 1960.

The acute and prolonged response of the body to physical effort was examined over a 12-year period in more than 250 marathon runners competing in 5, 10, and 26 mile races and compared with 40 nonrunners of corresponding age, height, and weight. Characteristic electrocardiographic, radiologic, and electrolytic changes occur from this activity, and the heart is enlarged uniformly without evidence of disease. Recognition of this fact is important in the differential diagnosis of cardiac enlargement. Questions and answers are transcribed at the conclusion of the article.—*David H. Clarke.*

4. BRAUNWALD, EUGENE, and KELLEY, EUGENE R. "The Effects of Exercise on Central Blood Volume in Man." *Journal of Clinical Investigation* 38: 413-19; February 1960.

The effect on central blood volume of ten minutes of moderately heavy leg exercise in the supine position was studied in ten normal male subjects. Central blood volume was calculated by the Stewart-Hamilton formula from arterial dye-dilution curves following

superior vena-caval or right atrial injection. Oxygen consumption and cardiac index increased during exercise. Central blood volume increased from 141 to 745 ml with exercise, and declined by an average of 375 ml during a 20-minute recovery period.—*R. H. Rochelle.*

5. Caswell, Hollis L. "Problems of Doctoral Study in Education." *School and Society* 88: 373-76; October 22, 1960.

This is an article commenting on the inadequacy of many doctoral programs to carefully select prospective students, and then to stimulate and motivate them as they pursue their work. Too often, the competency of some students to undertake doctoral study is not considered at all, and the individual merely amasses enough credits from a hodgepodge of course offerings to satisfy the requirement for the degree. Consequently, such students do not gain mastery of a field planned on the basis of recognized requirements for knowledge and competence, which should be a principal objective of doctoral study. —*T. Erwin Blesh.*

6. Christensen, Erik Hohwu; Hedman, Rune; and Holmdahl, Inga. "The Influence of Test Pauses on Mechanical Efficiency." *Acta Physiologica Scandinavica* 48: 443-47; 1960.

Two subjects performed a given quantity of work on an ergocycle within one hour. The work was carried on under four conditions: I, without rest pauses; II, 2 min. work followed by 3 min. rest; III, 0.5 min. work, 0.75 min. rest; IV, 24 min. work, 6 min. rest. The energy cost per kpm of work or the mechanical efficiency was practically the same in all cases. With the total number of heart beats above resting level as an index of fatigue, condition III was best.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

7. Cotes, J. E., and Meade, F. "The Energy Expenditure and Mechanical Energy Demand in Walking." *Ergonomics* 3: 97-119; April 1960.

The energy expenditure, the vertical lift work of the trunk per step, and the leg and foot lengths have been measured for 11 young male subjects walking on a horizontal treadmill at varying speeds. The vertical lift per step is a geometric function of the lengths of the leg, foot, and pace. The energy expenditure of walking at natural step frequency on the horizontal treadmill is linearly related to the vertical lift work which is the product of lift per step, step frequency, and body weight. The energy expenditure of horizontal walking is linearly related to the square of the forward velocity. Prediction of walking energy expenditure has been attempted using both the lift work and velocity squared relationships.—*David H. Clarke.*

8. Coye, R. D., and Rosanditch, R. R. "Proteinuria during the 24-hour Period following Exercise." *Journal of Applied Physiology* 15: 592; July 1960.

The urine of football players (no mention of position played, the duration of play or the extent of physical contact) was collected 4 days before and for 24 hours following participation in a practice game. Substantially more protein was found in the urine after the game than before. Renal clearance of serum albumin and globulins increased as a result of exercise. After the game, albumin was cleared relatively more rapidly than the globulins as indicated by an increased A/G ratio in six of the nine players on whom these measurements were made. Excretion of protein was more variable before the game than after. An explanation of the mechanism of postexercise proteinuria was not attempted; however, it does appear by comparing the present study with other investigations that the initial marked proteinuria after intense exercise is related to an increase in glomerular permeability while the delayed and lower level proteinuria that persists for several hours may be related to selective tubular reabsorption of albumin. These possibilities need further study.—*E. R. Buskirk.*

9. GORDON, NORMAN B. "Learning a Motor Task Under Varied Display Conditions." *Journal of Experimental Psychology* 57: 2; February 1959.

The purpose of the study was to test the hypothesis that stimulus changes affect the kind and amount of learning and retention needed to perform a motor task. Two-handed tracing responses were required in the context of four variations of stimulus inputs. Sixteen groups of subjects were used. A four by four factorial design was used to study learning and all possible transfer combinations.

Results gave evidence that supports the hypothesis that what is learned, and hence transferred, is a function of the amount and kind of stimulus information available in training. The amount of transfer is a function of both the transferable learning that took place during training and the revelance of the training for a given transfer task.—*Edna Willis.*

10. MICKEE, WALLACE P., and BOLINGER, ROBERT E. "Caloric Expenditure of Normal and Obese Subjects during Standard Work Test." *Journal of Applied Physiology* 15: 197-200; March 1960.

No consistent differences have been noted for age, sex, race, or emotional state in the performance of standard exercise tests. Nineteen obese subjects and 25 normal persons were studied during rest and during a standardized exercise to valuate the hypothesis that obese persons differ from normals in exercise efficiency. The caloric expenditure during the basal state is significantly greater for obese persons than that for the nonobese. This difference is related to the increased surface area of the former. There is no difference in work efficiency between the two groups, but female subjects show significantly higher caloric expenditure during exercise. This may reflect the fact that increased mass in the male includes more muscle tissue, while that in the female includes more fat.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

11. O'CONNELL, EUGENE R. "The Effect of Local Isometric Muscular Activity on Local Skin Temperature." *Journal of the Association for Physical and Mental Rehabilitation* 14: 74-75; May-June 1960.

Twenty-four subjects (17 men and 7 women) on two separate occasions performed 30 maximal contractions with the right forearm flexor muscles in a 60-sec. time period. Left and right arm surface skin temperature recordings were made over the belly of the biceps muscle with the Clark and Trolander thermistor thermometer, such measurements being made immediately before exercise, immediately after exercise, and after three minutes of post-exercise rest. The left arm served as a control for both experiments. Although the temperatures of both arms increased, the right arm, three minutes after exercise, had a significantly higher mean temperature than the left arm in both experiments (mean difference 1.00 and 1.13 deg. F, respectively). Discussion of this thermal lag is presented.—*David H. Clarke.*

12. RASCH, PHILIP J.; MANISCALCO, RUTH; PIERSON, WILLIAM R.; and LOGAN, GENE A. "Effect of Exercise, Immobilization, and Intermittent Stretching on Strength of Ligaments of Albino Rats." *Journal of Applied Physiology* 15: 289-90; March 1960.

The literature reveals almost nothing on the effects of exercise or stretching on ligamentous strength. Sixty male albino rats were divided into four groups. The first group ran in an exercise drum, the second was subjected to repeated stretching of one hind limb, the third group had one hind leg immobilized, and the fourth served as controls. At the end of 4 weeks (equivalent to 120 weeks in man), the animals were sacrificed, the muscle dissected from the hind limbs, and the amount of weight necessary to tear the knee ligaments apart was determined. Analysis of variance revealed no statistically differences between groups, leading to the conclusion that neither exercise, stretching, nor immobilization affected the strength of the knee ligaments in adult albino rats.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

13. ROHMERT, W. "Die Armkrafte des Menschen in Stehen bei verschiedener Körperstellung" ("Human Armstrength while Standing in Varoius Body Positions"). *Arbeitsphysiologie* 18: 175-90; January 1960.

Six men and four women (age 17-28 years) pulled, pushed, and twisted the arm and hand with maximal force against a dynamometer, while standing erect with one arm extended horizontally. In this position the greatest strength per unit of body weight was registered when the feet were separated rather than kept together. The pulling and pushing forces also increased progressively with raising or lowering of the extended arm above or below horizontal. Pronation gave higher scores than supination. The females exerted about 40 percent less force than the males in all positions, except those where the body weight could not influence the score, i.e., feet together, arm horizontal. Graphic representations show the optimum body positions.—*J. Royce.*

14. ROHMERT, W. "Ermittlung von Erholungspausen für statische Arbeit des Menschen" ("Determination of the Duration of the Recovery Period for Static Work in Man"). *Arbeitsphysiologie* 18: 123-64; January 1960.

The length of time that a static contraction could be held at 25, 50, 75, and 100 percent of the maximal strength was measured, as well as the duration of the recovery period which was expressed as percent of the contraction time. Twelve different muscle groups were tested on a total of 12 male and 9 female subjects. A mathematical equation was developed to express the necessary recovery time as a function of the contraction duration and percent maximal force used. The factors in this equation were considered independent of sex or muscle group. It showed that a contraction could theoretically be held for an indefinite period at 15 percent of the maximal strength. A corresponding nomogram was presented, which made it possible to make a quick estimate of the recovery time when the maximal strength and the duration of a static contraction at any level was known.—*J. Royce.*

15. SLOAN, A. W. "A Modified Harvard Step Test for Women." *Journal of Applied Physiology* 14: 985; November 1959.

In an effort to equate fitness index scores between men and women, an experiment was conducted to establish a step height for women that would produce scores equivalent to those obtained with a 20-in. step for men. The 20-in. step is too high for most women. They frequently develop local fatigue of leg muscles and the test is not a good measure of respiratory-cardiovascular performance during sustained muscular effort. A suitable step height of 17 inches for women was found to be comparable to a 20-in. step for men. Both the fitness index and the distribution of individuals in the categories of physical fitness (poor, average, good) correspond reasonably well at these heights.—*E. R. Buskirk.*

16. VOLKART, EDMUND H. "Man, Disease, and the Social Environment." *Postgraduate Medicine* 27: 257-60; February 1960.

Both medicine and social science are concerned fundamentally with man and his behavior. All sciences have overlooked one fundamental consideration: the state of man in health or illness is a total function of interaction between the internal environment, the external environment, and the social environment. One central question is whether the social environment is an actual or potential variable in health and disease. The bulk of infectious and communicable diseases have been brought under control, but they have been replaced by chronic and disabling conditions. Such illnesses often seem associated with the person's relationships to social environment. The patient should be seen as a person constantly interacting with his social environment. The variables are obscure; they may lie in the stress mechanisms. The course and outcome of illness may depend more than we realize upon the social environment of the patient. We need more studies of the influence of the doctor-patient relationship and the hospital as a social organization on the course of therapy and rehabilitation.—*Philip J. Rash, Journal of the Association for Physical and Mental Rehabilitation.*

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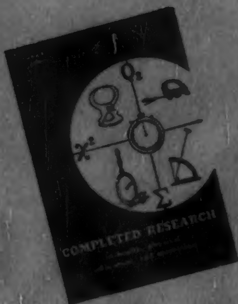

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